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March 1983 £1

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96 pages

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MARCH 1983, NUMBER EIGHT

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Paul Thompson
Promotion Manager
Pat Bitton
Publisher
Stanley Malcolm
Designers and Typesetters
GMGraphics, Harrow Hill
Graphic Designer
Phil Kanssen
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You are welcome to submit articles to the Editor of *Acorn User* for publication. *Acorn User* cannot undertake to return them unless a stamped addressed envelope is enclosed. Articles should be typed or computer written. Black and white photographs or transparencies are also appreciated. If submitting programs please send a cassette or disc. Payment is £50 per page or pro rata. Please indicate if you have submitted your article elsewhere. Send articles, reviews and information to: The Editor, *Acorn User*, 53 Bedford Square, London WC1B 3DZ.

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Second processor timings

BENCHMARK timings from Acorn for the BBC micro with a 6502 second processor take the machine from third to first place in the top ten speed ratings for micros.

According to October's *PCW*, the Olivetti M20 was top in all the machines they reviewed. The BBC micro came third, with the DAI second.

Even more interesting is a price comparison. The DAI is no longer sold in Britain, the Olivetti costs over £2000, and the Beeb with the 6502 second processor about £600.

The second processor uses the same eight-bit chip as the Beeb – a 6502 microprocessor. It is this which performs all the calculations within the machine.

As well as increasing the machine's speed by about half, the second processor means an extra 64k of RAM can be used.

Two more second processors are planned, based on the eight-bit Z80 and 32-bit 16032 chips. Development of these is not as far advanced, but engineers at Acorn are already comparing the 32-bit system to *mini* computers, never mind micros.

Source of comparative timings and the benchmarks themselves is *Microprocessors and Microsystems* (October 1978 vol2 no5) with an update from *Personal Computer World* (October 1981). The benchmarks are listed in order according to benchmark 7.

	1	2	3	4	5	6	7	8	7+8
3MHz BBC in 6502 Second Processor	0.42	1.73	4.95	5.25	5.51	8.46	13.18	3.08	16.26
2MHz BBC	0.61	2.6	7.43	7.88	8.27	12.69	19.77	4.62	24.39
1MHz Atom Basic	0.50	5.07	9.49	10.8	13.85	19.14	31.06		
4MHz 380Z TDL	1.4	6.5	13.2	13.9	15.0	22.3	31.6	6.2	37.8
4MHz Osbourne 1	1.4	4.4	11.7	11.6	12.3	21.9	34.9	6.1	41.0
4.77MHz 8088 IBM	1.5	5.2	12.1	12.6	13.6	23.5	37.4	3.5	40.9
1MHz BBC in ATOM	1.21	5.20	14.86	15.75	16.53	25.39	39.54	9.24	48.78
Vic20	1.4	8.3	15.5	17.1	18.3	27.2	42.7	9.9	53.6
Applesoft	1.3	8.5	16.0	17.8	19.1	28.6	44.8	10.7	55.5
Pet2001	1.7	9.9	18.4	20.4	21.7	32.5	50.9	12.3	63.2
1MHz 6809 TRSCOL	2.0	11.3	22.2	23.9	27.0	41.5	61.1	13.0	74.1
ZX81 fast mode	4.5	6.9	16.4	15.8	18.6	49.7	68.5	22.9	91.4
ZX Spectrum	4.8	8.7	21.1	20.4	24.0	55.3	80.7	25.3	111.0
ZX81 slow mode	17.7	27.2	65.3	63.0	74.2	199.3	275.6	91.6	367.2
*Olivetti M20	1.3	4.0	8.1	8.5	9.6	17.4	26.7	1.6	
*BBC	1.0	3.1	8.2	8.7	9.1	13.9	21.4	5.1	

The processors' cycle times are related to their clock frequencies as follows:
6502 cycles per second equals clock frequency
Z80 cycles per second equals clock frequency divided by 2.5
6809 cycles per second equals clock frequency
8088 cycles per second equals clock frequency divided by 4
Thus a 2MHz 6502 is vaguely equivalent to: 5MHz Z80, 2MHz 6809, 8MHz 8088.
The 1MHz timing applies to Atom and Acorn System versions of BBC Basic.

*These two timings are from *PCW* (October 1982). The timings are not strictly comparable with the figure above as *PCW* used a pre-production BBC machine. Also, the BBC machines timed themselves in the Acorn figures.

Micros in intensive care

A HOSPITAL is so delighted with its four BBC micros that it is planning to buy a dozen more. St Thomas's Hospital in London installed the first of its micros in an intensive care unit.

The consultant in charge believes hospitals could easily afford to equip their intensive care units with the BBC micro – and save money.

St Thomas's plans to use the three other micros to monitor heart-related problems, artificial kidney systems for renal dialysis and incontinence in children.

Other possibilities for the Beeb's use are being explored by the hospital administration. It could, for example, store every detail of a patient's condition as an addition to medical records.

Show dates

□ The Manchester Home Computer Show opens its doors from April 22 to 24. The Midland Hotel is the venue. Details from ASP, 145 Charing Cross Rd, London WC2H 0EE.

□ Artificial Intelligence and Education is the theme of a conference to be held at Exeter University on April 16–17. Seymour Papert (as in *Logo*) will be there and tutorials will be held on *Prolog* and *Logo*.

Details from Masoud Yazdani, Computer Science, Exeter University, Physics Building, Stocker Rd, Exeter EX4 4QL. Tel: (0392) 77911 ext. 216.

□ Bristol University is running several courses using BBC micros. Contact D. Wilde or Mrs. L. Skinner, Extramural studies, 32 Tyndalls Park Rd, Bristol BS8 1HR. Tel: (0272) 24161

Telesoftware launch due

THE BBC's telesoftware service could be ready for an April launch. Acorn's teletext adaptors were on show at January's BBC micro trade exhibition and are starting production.

Teletext is a process whereby information transmitted by BBC's Ceefax and ITV's Oracle can be accepted and stored by a micro. This removes the need for a special TV set and means software can be broadcast and downloaded into a computer directly.

Graham Clayton, head of Ceefax, explained that modifications to his computers which transmit teletext information were complete. 'The BBC end is ready to start broadcasting when we want,' he said.

Software available will be educationally-biased, with 50 programs coming from the Microelectronics Education Programme and eight from Brighton Polytechnic. It will be changed fortnightly at first, but this frequency will be increased as the number of users grows.

Brighton Polytechnic took part in the earliest telesoftware projects and is undertaking research to assess its value in education.

A third source of software is the general public. 'People are already sending in a steady trickle of listings,' said Graham Clayton. 'We are negotiating a very small payment and have produced guidelines for writers.'

However, the main problem is still the BBC's inability to pay commercial rates for telesoftware as it is unable to charge users.

Memory back-up

A BACK-UP memory device should now be available for the BBC micro. Greenwich Instruments have developed an adaptor for their NVR64, to store the Beeb's memory once the power is switched off.

The adaptor plugs into the 1MHz extension bus and will be available with the necessary software from late February costing about £25. The NVR64 itself costs £375.

The device has 64k of usable memory, protected by an internal lithium power system for up to 10 years. The manufacturers claim it is exceptionally fast – programs load and save in a fraction of a second – and due to the absence of moving parts, is suited to hostile environments.

Contact Greenwich Instruments at 22 Bardsley Lane, Greenwich, London SE10 9RF. Tel: (01) 853 0868.

Reject call

DO YOU have something in common with Einstein, Winston Churchill, Puccini, Rudyard Kipling, Jimmy Young or Margaret Thatcher? They have all been rejected at some time or other.

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Smiling beauty prize

WE couldn't resist holding a little 'balloon' competition about these two smiling beauties. They are (left) Chris Curry, joint managing director of Acorn and David Allen, produce of BBC TV's *Making the Most of the Micro*. What do you think they're thinking or saying? A prize of software to the value of £20 is offered for the best balloons. Entries on a postcard please, addressed to *Acorn User* and marked 'GRIN'.

Digit-a-pic

THE Digitiser System, for the BBC model B, can reproduce pictures and diagrams or can be used to produce original designs. The user traces a picture and the co-ordinates are stored in the computer.

The digitiser costs £98, with a joystick an additional £48.95, both plus £4 postage and packing and VAT. Further details from B.S. Dollamore, Burton Road, Castle Gresley, Burton-on-Trent, DE11 9HA. Tel: (0283) 217905.

Beeb Forth toolkit

A FORTH toolkit has been produced by Level 9 Computing. It is designed to enhance their 'r q Forth' for the BBC micro. The toolkit has about 200 functions and is supplied on cassette for £10.

The toolkit is divided into sections, any of which can be loaded as needed. Some of the functions include: a 6502 assembler, turtle graphics, double-numbers, cassette file handling and bit-pattern manipulation.

Level 9 Computing can be reached at 229 Hughenden Road, High Wycombe, HP13 5PG. Tel: (0494) 26871.

Shop clubs

A Manchester-based software company, is starting its own users club.

It costs £5 a year to join, and members are entitled to discounts of up to 30% on tapes. There will also be a bi-monthly newsletter. Details from: Micro-Link at 830, Hyde Road, Gorton, Manchester M18 7JD.

TV robot link to micro

THE Buggy shown in the BBC's latest computer series is soon to go on sale.

This vehicle is designed to be controlled from the Beeb, and software will be provided to enable it to perform a variety of tasks, from following lights to mapping out boundaries.

It is about five inches square by five inches high and runs on three wheels driven by two stepper motors.

Economatics, who make the device, say it will cost about £125, including 13 programs, and will be available in April. It comes in an 'easily assembled' kit form and has collision and light detectors.

A pen operating system is planned, to enable the Buggy to be linked up to *Logo* packages and used as a turtle. The NEC course 'Interfacing and control systems' will include a teaching board to drive the Buggy.

Details from: Economatics Education Division, 4 Orgreave Crescent, Dore House Industrial Estate, Handsworth, Sheffield S13 9NQ.

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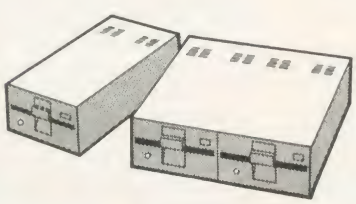

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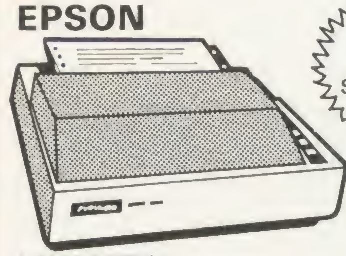

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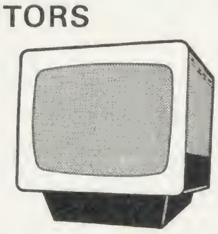

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Their address and phone number are given on page one, and they will deal with subscription and back number enquiries from now on.

A new service they offer is the ability to arrange subscriptions by credit card over the phone.

Details of back issues, a photocopy service and the arrangements for subscriptions are given on page 89.

Hidden message

SOMEWHERE in this magzine is a hidden message. We're not giving away any clues, but there's a year's free subscription awaiting the first person to find it.

Send your answer on a postcard, which must be posted, and we will not accept answers by phone. So there!

Autoprommer

THIS little box can not only blow EPROMs, but also run programs automatically on the Beeb.

Data files can be loaded from and dumped to cassette for all operating systems up to 1.2. It runs on 25 or 21 volts and takes power from the Beeb. The price is £120 plus VAT and postage. Details from ATPL, Station Rd, Clowne S43 4AB.

NEC to launch micro courses

THREE new computer correspondence courses are to be released by the National Extension College.

The first two – 'Structured programming in Basic' and '6502 assembly language programming' will cost £50 and be available this year. The third, 'Interfacing and control systems' is not yet accepting enrolments.

All the courses are based around the BBC micro, but will be applicable to other machines. Books of the courses will be jointly published with the BBC.

The NEC is now claiming over 100,000 users for its original course '30-Hour Basic' released as part of the BBC's Computer Literacy Project. It has also arranged for the City and Guilds of London Institute to offer a certificate in computer literacy.

Some people have criticised '30-Hour Basic' because it was not specific enough, although this was mainly caused by a lack of BBC micros when the course was written. This problem, graphically described by Richard Freeman in September's *Acorn User*, has now been overcome as there are now more than 50,000 Beebs about.

Details of courses from: NEC, 18 Brooklands Avenue, Cambridge CB2 2HN.

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SPINNIN

by David Allen, BBC producer

Most of the programmes in *Making the Most of the Micro* have now been shown,so this is a useful time to look at the software and hardware which is likely to be produced to support the series.

In programme one, 'The versatile machine', we see a number of demonstration programs. One of these helps to explain how data gets from tape into the computer's memory when a program is loaded. It was written by Ian Trackman and will probably be released by BBC Publications.

The sound monitoring program and the pressure pad weighting-machine software (written by BBC engineers Steve Lowry and John Mitchell) may also be available.

The BBC micro is used throughout the series to produce the closing superimposed credits, subtitles and names. This technique could be used on home videos.

'Getting down to Basic' is the first programme to show any coding. Although quite simple, programs have been written to show good practice and it is likely these will appear on Ceefax.

At the end of the programme we see programs written for schools by the Microelectronics Education Programme, as well as one from the *Welcome* tape. The two MEP programs will be transmitted free to viewers who have teletext decoders attached to their BBC micros.

'Strings and Things', programme three, looks at how the computer handles words and demonstrates a word processor.

We also look at procedures and structured programming. Ian Trackman demonstrates a patience-playing program with excellent graphics, and a couple of programs which play a dice game. One of these has been 'well' written, and shows the principles of good structure; the other is a 'bad' program with poor screen display, and poor error trapping.

The BBC Buggy in action. This small robot can negotiate mazes, follow lights and draw pictures. It should soon be linked to a Logo language, and may be used in an NEC course on control.

The TV picture on the left was set up using a technique developed by BBC engineers which has obvious possibilities for home video.

G OFF FROM THE MICRO

For those who want to learn more about structured programming there is a second National Extension College course coming up called *'Structured Programming on the BBC Microcomputer'*.

Programme five, 'Keeping a Record', helps to demystify databases and shows a simple friendly home database or 'record keeper' written by Ian Trackman.

We also see the BBC machine interrogating the *New York Times* database using software written by John Coll at Acorn. This converts the BBC machine into a 'smart terminal' and enables you to use the telephone to communicate with any mainframe computer capable of reading ASCII code.

Programme six is about business applications. It contains a demonstration of *UltraCalc* – a spreadsheet program similar to *Visicalc*. This software is important because it enables the small businessman to produce a financial model of his business.

Music, speech and 'intelligence' make up programme seven. This shows software which converts the BBC machine into a music synthesiser and demonstrates the musical equivalent of the word-processor – a music editor which enables you to create music, display it in 'proper' notation and then play it back, with harmony.

The speech chip – immortalising the voice of Kenneth Kendall – is shown in action, and this is now available for the BBC machine.

Control is the subject of programme eight. In this we show how various simple sensing devices can be interfaced to the BBC machine and how it can control mains operated devices.

We also show the BBC buggy, a wheeled vehicle which is controlled by the computer. It has a pair of precision stepping motors, a light sensor, a macro barcode reader, an elecromagnetically operated pen and two touch sensors.

Software is being written which should enable the buggy to, for example, map out its environment or find its way out of a maze as well as follow a light, negotiate its way round objects and follow bar-coded instructions.

Programme nine takes a second look at graphics, and various techniques such as 'colour switched' animation effects are demonstrated as well as the use of lightpens and graphics tablets.

Programme 10 deals with communications. We look at the use of the machine with the telephone and networking 'inking machines so they can communicate and share peripherals, a subject you will he hearing a lot more about.

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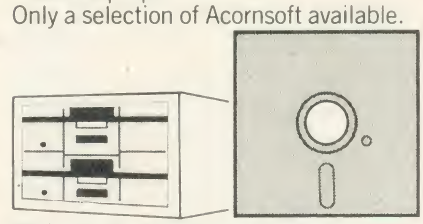

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John Vaux set three programs for the Beeb against each other – and a dedicated chess machine

MICRO TAKES ON CHESS MACHINE

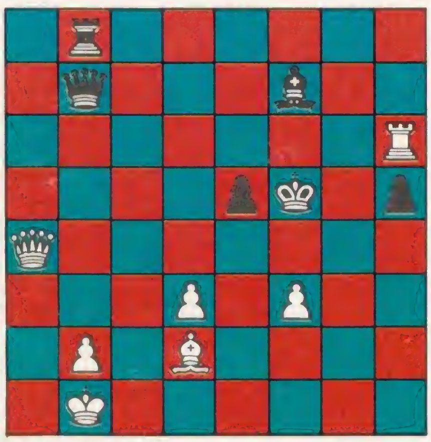


Figure 1. White to move

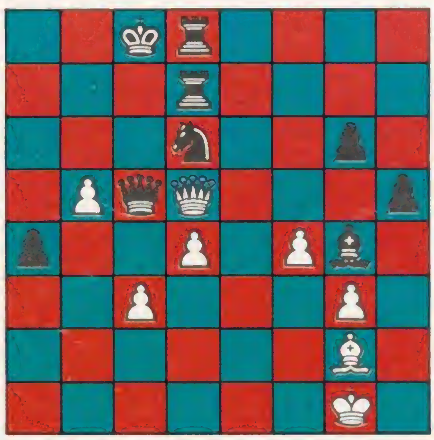


Figure 2. White to move

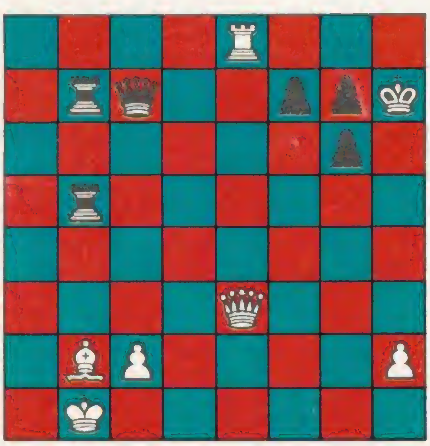


Figure 3. White to move

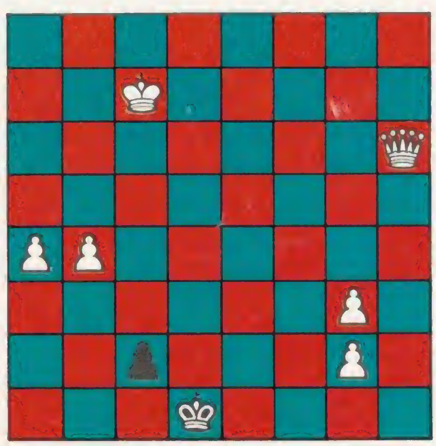


Figure 4. White to move

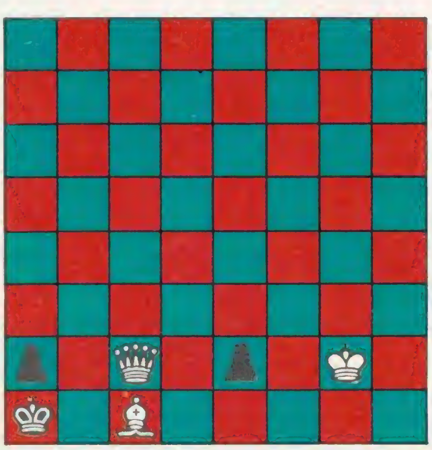


Figure 5. Black to move

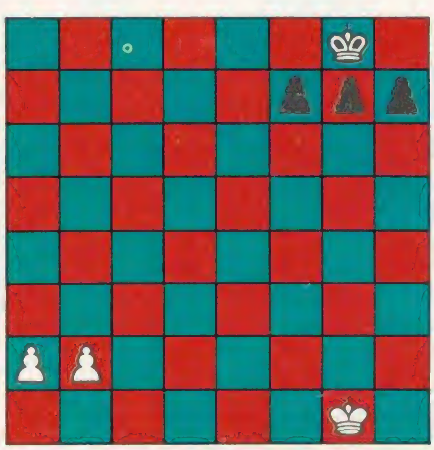


Figure 6. White to move

This is a review of three chess programs for the model B BBC micro. As an interesting comparison, one of the dedicated chess machines has been included in the test. The review looks at how well the programs play chess from various aspects of this complex game.

The three programs are from Program Power (abbreviated to PP), Bug-Byte (BB) and Computer Concepts (CC). The chess machine is the Mini Sensory Challenger (MSC). The programs loaded from the tape with no trouble except that the BB program is called 'BEEBCHESS' on the tape and 'CHESS' in the instructions. Documentation in all cases gave adequate information about all the facilities, although presentation ranged from a glossy booklet with the MSC to duplicated pages with PP and CC.

The facilities provided are wide ranging, with CC having the most (four typed pages of them). CC is the only program which uses the function keys. All provide various levels of play which can be changed at any time. All allow the setting up of a position for problem solving. Additional features include saving and reloading of a game printing a list of moves made, playing 'Blitz' (provided by PP – you move in 10 seconds or you miss your move!), changing the colour of the board and pieces (provided by CC), to name a few.

The CC display is the clearest. PP is reasonable but the difference between the pieces is not great. BB shows quite clear pieces but the relative sizes can be confusing (for instance, the pawns are bigger than the king). MSC of course does not have a display but uses actual pieces. Although these are small and fiddly they are quite easy to differentiate.

Clock display: BB has no clock, PP shows time taken for your moves only, CC has a clock for both sides.

CC can be set to play computer against computer, computer against human or human against human (in the last case it monitors for legal moves). At any time that it is a human's move CC can be asked to suggest a move.

Now we come to levels of play. MSC has four, one being the fastest and four being very slow. PP has six levels indicating the number of half-moves or 'ply' searched. Thus a mate in two is three ply (white-black-white-mate). BB has main levels up to nine indicating ply and sub-levels up to 99 indicating the number of moves tried at each level. CC has no less than four different level settings.

hese are called level, care, sublevel and speed, but these names do not really describe what they mean. All these settings provided by CC may be fun for the experimenter but are too complex for the average user.

Expensive chess machines have the more common standard opening move sequences stored in memory. For the first moves of these stored openings they do not need to 'think' and so move immediately whichever level they are playing at. None of the programs under review have this facility, although a plug-in module of openings is available as an optional extra for the MSC machine.

PP, CC and MSC playing white all prefer D2–D4 or E2–E4, apparently choosing randomly between them. BB preferred knight opening B1–C3 or G1–F3.

Playing black, PP, CC and MSC respond with sound moves. BB is less reliable and sometimes plays peculiar moves in the early stages. On one occasion BB's first move was G8–F6, it's second move F6–G8 and so after two moves it was back where it started!

Space does not permit me to go in detail into how well each program handled the opening moves, but BB was generally the least sound.

A good way to test chess programs is to give them set problem positions to solve, and there are many books from which such problems can be obtained.

Some are specifically designed to demonstrate the limitations of chess computers. Problems for this review were extracted from books listed at the end of this article. Illustrations of some of the positions are included so that you can try them on your chess machine or program to see how they compare with those in this review.

Each program was given nine mate-in-two (ie three-ply) problems. PP was found to be particularly good at these and correctly solved every one on level three, times being from 10 seconds to eight minutes. Having moved, it displays 'mate in one' to show that it recognises the fact. None of the others approached PP's mate-in-two performance, CC and MSC getting four correct and BB five.

Figure 1 shows an example they all succeeded on, times being: PP (on level three) 25 seconds, BB (on 3.99) six minutes, CC (on 3,0,0,4) 22 seconds and MSC (on level three) 55 seconds. The solution is: A4–E4 check, B7xE4; D3xE4 mate. Figure 2 shows an example that only PP solved in two minutes, BB (3.99) wrong in five minutes, CC (3,0,9,9) wrong in 18 seconds and MSC (3) wrong in one minute. The solution is: D5–A8 check, C8–C7; A8–B7 mate.

PP was so good at mate-in-two, it was put up to level five and given a couple of mate-in-three (five ply) problems to tackle. At this level you need something else to do while waiting. It 'beeps' when it has made it's move. PP solved both, one in 49 minutes the other in nearly three hours. Figure 3 shows the first one – see how well your chess program does! The solution is: E8–H8 check, H7xH8; E3–H6 check, H8–G8; H6xG7 mate.

I was impressed at how well PP handled these problems and surprised at the performance of the others. I would have expected any program claiming to be good to consistently solve mate-in-two situations even if for instance the first move is a queen sacrifice.

However, there were some situations which PP couldn't solve. Figure 4 shows a problem that was only solved correctly by BB. The others did not realise that it is OK to let black promote his pawn to a queen and then exchange queens resulting in a winning position with four pawns against nothing. They kept checking with the queen to prevent the promotion taking place!

Figure 5 shows a situation where a win is obtained immediately by promoting the pawn not to a queen but a knight. BB is apparently the only one that is capable of under-promoting a pawn. Later it was discovered that when it is your pawn being promoted BB asks what piece you want to promote to. The others all assume you want a queen.

Computer chess programs are reasonably good at the opening game and come into their own in the middle game in that unlike human players in complex situations they rarely make mistakes. On the other hand, they do not have sudden flashes of inspiration and see combinations beyond their normal horizon of searching. In the end game, the look ahead required usually increases considerably – especially with respect to pawns racing with kings to promotion. Figure 6 is an example of this. If white advances his A–pawn, the black king cannot reach it in time to prevent it promoting. BB handled this correctly at level 4.99 in 24 seconds. CC was correct on level 6,0,5,9, in five minutes. PP got it wrong at it's top level and MSC was also unable to solve it.

Only one BBC micro was available so I could not get the chess programs playing each other, but I did play each program against the MSC machine. Playing at level two, results were as follows:

MSC v PP. Three games played – PP won one, one was drawn by MSC obtaining a stalemate while PP was ahead on material, the other game was abandoned about equal when MSC tried to make an illegal move (maybe this was due to a mistake by me when transferring the moves from one to the other).

MSC v CC. Three games played – MSC won all three.

MSC v BB. Two games played – MSC won both.

These games took from about half an hour to an hour and a half each. As PP was the only program to beat MSC, two games were played between them at level three. One game was won by MSC in about two hours. In the other game PP won the queen but failed to build on its advantage and the game just drifted on aimlessly. It was abandoned on move 27 after two hours 40 minutes.

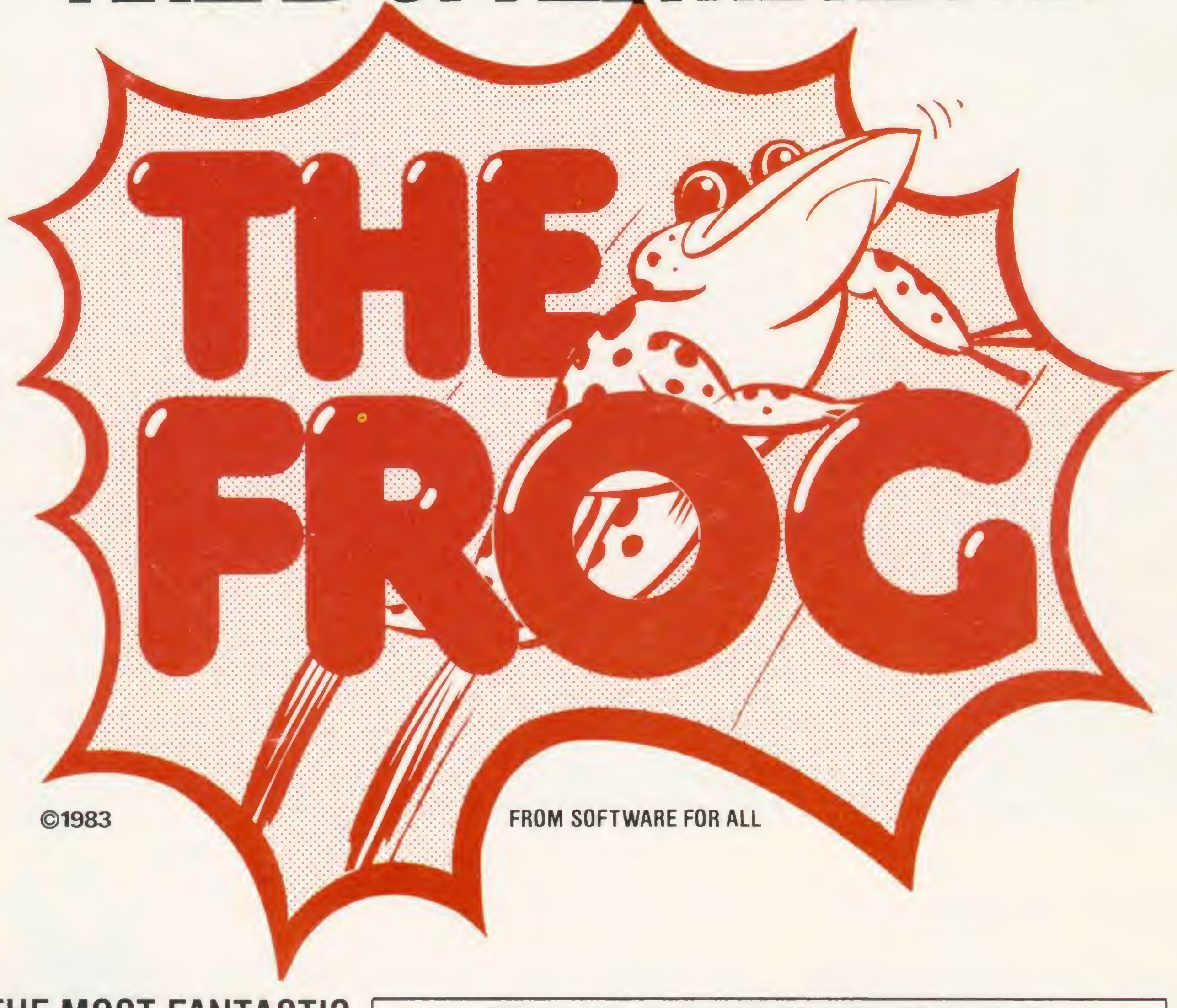
I was generally somewhat disappointed in the performance of all these programs. During tests, all occasionally made stupid moves so I do not think they would be good enough for the above average chess player. They could all give the less strong player a reasonable game at level two (each move taking about a minute) and a stronger game at level three (moves taking around three to five minutes). The MSC machine (£50) is no stronger than these chess programs. It is apparent that the strong player would need one of the expensive machines (£100 plus) to really challenge him.

Of the programs PP is the strongest – and also the cheapest at £7.95. CC has the best display and the most facilities (£10). BB has it's moments but is the least desirable of the three (£11.50).

Thanks to Ray Hodges Associates of Maidenhead for the loan of the MSC machine, to Program Power and Computer Concepts for the loan of their programs. The Bug-Byte program was purchased.

The problems were taken from: *How to get the most from your chess computer* by Julio Kaplan; *The Computer Chess book* by T.D. Harding; *Rate your own chess* by F. Donald Bloss.

THE PROGRAM THAT'S LEAPS AHEAD OF ALL THE REST...



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December's Forum gave a few ideas on cutting down on storage space by packing bytes. I want now to return to this subject and consider a different way of storing numerical information economically.

Suppose you wish to store in a particular sequence the horizontal and vertical positions of a pixel (using the Beeb's absolute references of 1280 by 1024), the mode of connection to the next pixel in sequence (ie whether solid line, dotted line, triangular filled or not connected) and the colour of the connection (or the pixel itself if not connected). We will code the connection as 4 for not connected, 1 for dotted, 0 for solid, and 5 for triangular (the reason for this will become clear). And the colours are 0 to 7, depending on mode: no flashing colours are included for now.

Our method of storage rests on our constructing a 10-digit number formed by the four digits of the horizontal coordinate (X), followed by the four digits of the vertical coordinate (M) and the colour (C). This is done by computing $1{,}000{,}000X + 100Y + 10M + C$ and will fit into just one integer storage location of four bytes, for the maximum positive number permissible is &7FFFFFFF or 2,147,483,647. Thus for example we can store coordinates of (963,45), a connecting mode of 5 and colour 5 as 963,004,555. And the number corresponding to (1200,1021), a connecting mode of 0 and colour 6 is 1,200,102,106. Each combination has a unique number corresponding to it and each number has a unique combination corresponding to it (assuming the combination is possible).

This is an economical way of storing data. For example, to store data on 100 connections requires just over 400 bytes of storage using an integer array; and 2k of storage gives you over 500 connections.

Accessing the information is easy: for the Ith point the coordinates are A%(I)DIV1,000,000, (A%(I)MOD1,000,000)DIV100. The connecting mode is given by (A%(I)MOD100)DIV10, and the colour by A%(I)MOD10.

We can do even better than this since we can include flashing colours also, in the same amount of storage. If the colour is flashing we shall use a negative number: otherwise positive. A function to do

£20

Benjamin Finn earns £20 for this tip on using passwords

Here is a very useful routine for inserting a password system into programs on the BBC model A or B. It can be placed anywhere (preferably at the start) in a program, but nonetheless is unlistable.

The program should be renumbered to clear lines 0,1 and 2, and listing 1 entered.

Note that there should be no blank spaces before or after the REMs, and that you may insert any phrase as a password instead of PHRASE (line 1).

Now you should enter the second listing below which makes these lines invisible. If you now list the program lines 0-2 have disappeared, and there are no traces of any alterations.

However, when the program is run the computer will say:

Password?

and you wil have to enter one. If it is correct all will be well; but a wrong password will cause the message:

Syntax error
Bad program

and you will find that your program has been erased!

If ever you forget your password but remember the line it is stored in, just enter:

1 (or the line number used for the password routine) and press RETURN

This will delete the offending line, and you may carry on with the program.

☐ **To recover the program if you mistakenly type in the wrong password, execute the following:**

?PAGE=13:?(PAGE+3)=12

Listing 1.

```
0REM1234567
1 INPUT"Password? "A$:IFA$<>"PHRASE" !PAGE=0:RUN
2REM123456
3 Rest of program...
```

Listing 2.

```
A=PA.:$(A+5)=STRING$(5,CHR$127)
A?10=11:A?11=21:A=A+9:REP.A=A+1:U.?A=244
$(A+1)=STRING$(5,CHR$127):A?6=6
```

Program 1.

```
32000 DEF FNENCODE(X%,Y%,M%,C%):LOCAL N
%,R%
32010 IF C%>7 THEN C%=C%-8:N%=-1 ELSE N
%=1
32020 R%=(1000000*X%+100*Y%+10*M%+C%)*N
%:IF R%=0 AND N%=-1 THEN =-2000000000 E
LSE =R%
```

Program 2.

```
32000 DEF PROCDECODE(I%)
32010 IF I%<0 THEN _C%=8 ELSE _C%=0
32020 I%=ABS(I%):IF I%=2000000000 THEN
I%=0
32030 _X%=I%DIV1000000:_Y%=(I%MOD100000
0)DIV100:_M%=(I%MOD100)DIV10:_C%=_C%+I%
MOD10
32040 ENDPROC
```

Program 3.

```
32000 DEF PROCPLOT(X%,Y%,M%,C%)
32010 GCOL0,C%:PLOT(5+16*M%),X%,Y%
32020 ENDPROC
```

this is given in program 1, called FNENCODE (X%,Y%,M%,C%); in program 2 a procedure PROCDECODE (I%) is given. The function is used to encode the information (the parameters are horizontal coordinate, vertical coordinate, connecting mode, and colour – this time from 0 to 15). Since there is only one value to be returned, a function is the most convenient way of returning the information.

The procedure in the second program is used to decode the information. Notice we need four global variables to return the information. Conforming to our ideas in December's issue, we use as a prefix for the globals with obvious notation to correspond to the parameters in FNENCODE. If we want to plot the points immediately we do not need the globals. Instead we can pass the values to a plotting procedure. PROCPLOT (X%,Y%,M%,C%) is such a procedure given in program 3. It should now be clear why we chose the numbers we did for the connecting modes.

It is possible to squeeze even more information into these four bytes. The sixth digit from the right will always contain 0 or 1. It follows that we can additionally store information on a further variable with up to five values, in this sixth digit position. Moreover, if we really want to pack the bytes, we can store information on another variable with two values, this time in the first digit position on the right. But you might now feel economy is being carried too far!

The most important use of these procedures is to save and retrieve graphics information from tape or disc. This may facilitate the creation of an economical 'look-up' table of data to speed up plotting, for example. But other uses are possible.

SHIFT-LOCK AND CAPS-LOCK CONTROL

Many people have asked whether it is possible to control the Shift-lock and Caps-lock keys from the program. The answer is 'yes', but there are two problems: the method is conditional on which operating system is in use; and you will not be able to use your program across the Tube without modifications.

The general syntax is as follows:

?B%=&10 sets Shift-lock;
?B%=&20 sets Caps-lock;
?B%=&30 releases both locks;
?B%=&40 sets both locks.

In OS Version 0, B%=&D8 : in OS Version 1,B%=25A. An easy way to ascertain which OS is installed directly from the program is to execute:

IF ?&FFFE=164 THEN <OS 0> ELSE <OS 1>

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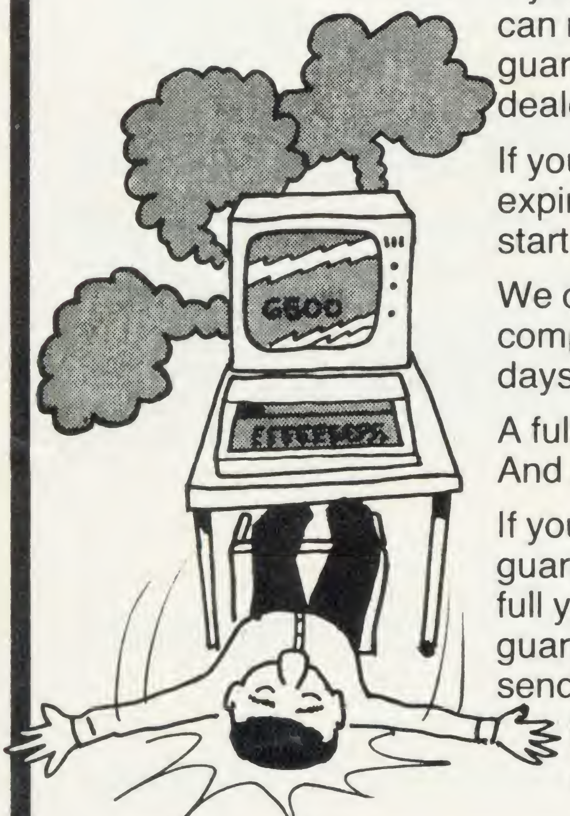

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MUSIC ON A MICRO

Jim McGregor and Alan Watt assess the values and limitations of the sound facilities on the BBC micro, and show how it can be used for serious instrumental synthesis

Can the sound and envelope on the BBC micro be used for serious instrumental synthesis or are they just for fun? What is instrumental synthesis and can a computer make violin sounds like Yehudi Menuhin?

The answer to the first question is a qualified yes, and this article explores the BBC facilities, and their values and limitations in instrumental synthesis, drawing on some musical physics to try and put them in perspective. We will not go into detail on the meaning of the parameters in the envelope statement, but rather concentrate on how the parameters influence sounds. Also at this stage we will concentrate on the amplitude parameters in the envelope statement.

The answer to the second question is also yes. Given sufficient resources there is no technical reason why a computer could not accurately reproduce or copy a master musician playing eight bars of a Mozart violin concerto on a Stradivarius. This may seem surprising, and it would be pointless – a tape recorder is a better device for listening to Yehudi Menuhin. However, providing sufficiently fine measuring devices are available to capture every subtle nuance, change in intensity, pitch, harmonic envelope, etc, a performance could be reconstructed from computer controlled fragments.

The real point of instrumental synthesis is to make a computer sound like a traditional instrument or make unique sounds unlike any existing instrument.

Perhaps it is best to introduce sound by tying up the aural impressions or qualities of sounds with visual impressions. Any sound is a pressure variation with time, or successive compressions and rarefactions of air. This pressure variation can be converted into a variation of electrical current as a function of time, using a transducer such as a microphone, and the electrical current or signal displayed on an oscilloscope. This gives us an idea of what sounds look like when converted into such a signal. 'Seeing' sounds then provides a useful bridge between the aural impressions of sounds and the numbers we have to supply to a computer program to generate the sounds. Various examples are shown in figure 1.

A pure tone has a regular sinusoidal appearance and can only be generated perfectly electronically or mechanically (or electromechanically) by a device such as a tuning fork. Musical instruments do not generate pure tones but a complex mixture of pure tones, each mixture a function of many variables, the most pedominant being the instrument type and the player. An oboe produces a mellow smooth tone, a trumpet a much harsher cutting tone.

Sound generated by the BBC micro is not a pure tone either. It is a distorted square wave (figure 1), which is why it sounds 'electronic' rather than instrumental. Its other less than desirable characteristic is that it changes shape as a function of frequency or pitch. This means the character of the sound changes with frequency.

Differences in sounds produced by different musical instruments – or in the sounds produced on one instrument played by different players – can be quantified by two mathematical models.

▶page 22

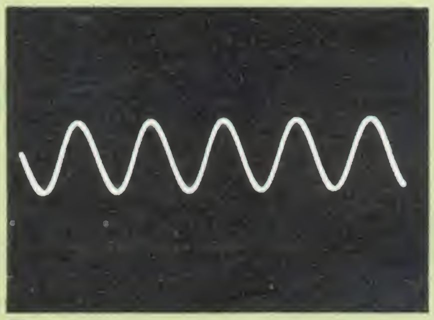
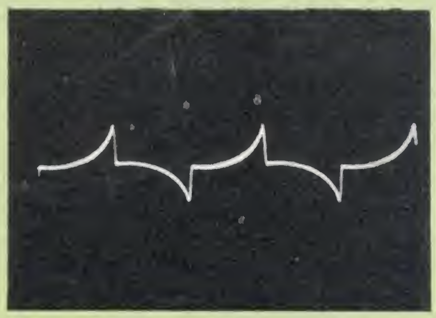
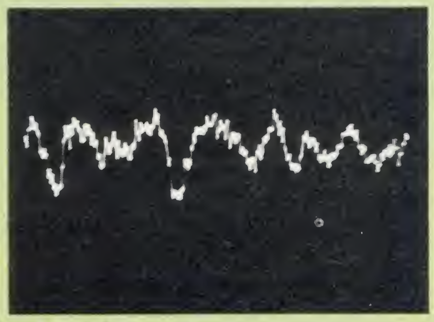


Figure 1.
Pure tone middle C

Middle C on the BBC micro



Bottom C on the BBC micro



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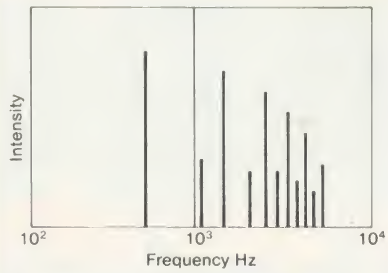


Figure 2. Harmonic envelope of clarinet playing continuous note of 523Hz

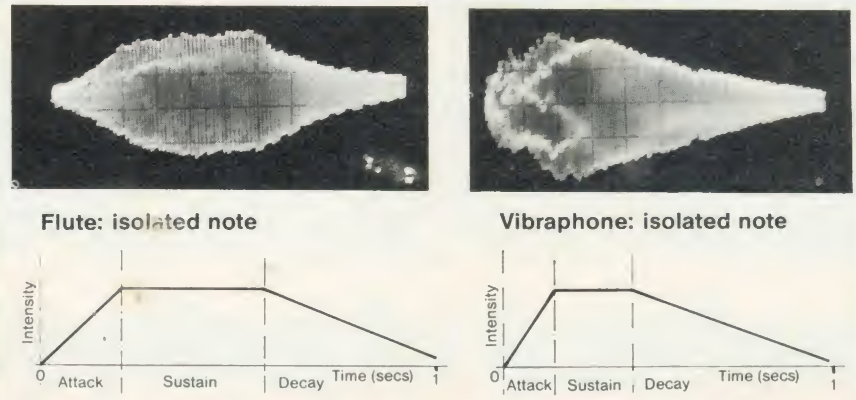


Figure 3. Piecewise linear approximations to instrumental transients

First consider a note played on an instrument and held at a steady volume. This exercise carried out on a trumpet will sound totally different from the same continuous note played on an oboe. This is because the mechanical design of an instrument causes vibration modes at different frequencies and the different mechanical designs mean that different instruments exhibit varying vibrational strengths at different modes. A continuous note played on any instrument can be considered to consist of a series of superimposed sine waves all having different frequencies and amplitudes. This is sometimes called a harmonic envelope. The harmonic envelope for a clarinet is shown in figure 2.

The diagram indicates that this note is made up of a sine wave undulating at 523 (the frequency of top C) plus a number of other sine waves or harmonics undulating at twice, three times, four times etc, the fundamental frequency of 523. The fundamental sine wave is the one with the highest amplitude, and the relative amplitude of the other harmonics define a harmonic envelope. The overall shape of this envelope gives a note a characteristic sound, and this shape varies generally with the frequency of the note and the way an instrument is played. Even the same note on the same instrument can produce different envelopes depending on the way it is blown.

The varying mechanical designs of instruments produce completely different harmonic envelopes. Computer synthesis of continuous tones of different instruments can be achieved by playing pure sine waves of different amplitude and frequency simultaneously. The capacity for the BBC computer to do this is, however, limited as it has only three tone channels, and the tone generated is not a pure sine wave, but a square wave, already possessing its own harmonic envelope. To convincingly reproduce the sound of a continuous note on a particular instrument would need many more than three tone channels, and all of these would have to produce pure sine waves.

There is, however, another important consideration in the sound a particular instrument makes that the BBC computer can synthesise accurately. This is the amplitude envelope. Above we considered a continuous note, but musical notes are not continuous. They start and stop, some more abruptly than others. They take a certain time to build up and decay. These times are characteristic of different instruments.

Figure 3 shows one of a series of isolated notes at the same frequency played on a flute, together with one of a series of notes played on a vibraphone (a tuned percussion instrument like a xylophone with metal bars). The waveforms show that the undulations the instruments make (that themselves can be synthesised

Program 1. Turns keyboard into 'piano'

```
  1 ENVELOPE 1, ......
  2 ENVELOPE 2, ......
  3 ENVELOPE 3, ......
  4 ENVELOPE 4, ......
  5
 10 octave = FALSE : envelope = -15
 20 keys$ = "ZSXCFVGBNJMK,L./: "
 30 *FX 11, 1
 40 *FX 12, 1
 45
 50 currnote$=GET$
 60 REPEAT
 70   PROCcheckforstops
 80   pitch = INSTR(keys$, currnote$)*4 + 37
 90   SOUND 1,envelope,pitch,255
100   IF octave THEN SOUND 2,envelope,pitch+48,255
110   REPEAT
120     note$ = INKEY$(2)
130   UNTIL note$<>currnote$
140   SOUND &11, 0, 0, 0
150   SOUND &12, 0, 0, 0
160   IF note$ = "" THEN currnote$ = GET$
                    ELSE currnote$ = note$
170 UNTIL currnote$ = " "
175
180 *FX 12,0
190 END
200
210 DEF PROCcheckforstops
220   IF INSTR(keys$, currnote$)>0 THEN ENDPROC
230   IF currnote$ = "O" THEN octave = NOT octave
240   IF currnote$ = "P" THEN envelope = -15
250   IF INSTR("1234", currnote$) THEN
         envelope = ASC(currnote$)-ASC("0")
260   REPEAT: currnote$ = GET$
270   UNTIL INSTR(keys$, currnote$)
280 ENDPROC
```

from a number of pure tones) have their amplitude controlled by the transient characterisitc of the instrument. The amplitude of the undulations build up, sustain and decay. The attack time on the flute (the time it takes the sound to build up to a maximum) is much longer than the attack time for the vibraphone. The sustain time of the flute is longer than that of the vibraphone. (Although sustain time in a wind instrument depends on the player, figure 3 shows the sound produced by a musician instructed to play as short a note as possible.) A piano, essentially percussive, has a transient that exhibits a fast build up and long sustain. This is almost the opposite of an organ where the note takes a longer time to build up but decays sharply as the air supply is abruptly cut off. In fact a tape recording of a piano played backwards will make organ sounds and vice versa.

The rate at which a note builds up and decays and how long it is sustained for can be controlled accurately by the envelope statement, but the undulations whose amplitude is controlled are square waves and not pure tones or 'trumpet-like' or 'clarinet-like' undulations. Approximate instrumental synthesis is still possible and this demonstrates that transient control or control over the amplitude envelope, is just as important as (if not more important than) the harmonic envelope in determining the unique sound of an instrument.

There are other subtle factors involved in the recipe for an instrumental sound but we have not the space to go into them here.

At this stage it is useful to introduce a program that will play notes from the keyboard and also change the characteristics of the note played as soon as an 'effect' key or 'organ stop' is pressed. You can then play tunes from the keyboard and instantly change the sound produced by pressing an 'effect' key, just as you would on an electronic organ. The structure of the program is amenable to extension.

Program 1 causes the keys on the bottom row of the keyboard to behave like the white notes on an organ or piano, with the keys on the row above behaving like black notes where appropriate. Key C represents middle C. The 'effect' keys 1, 2, 3, 4 select one of four envelopes for playing subsequent notes and the P key (P for Plain) causes subsequent notes to be played without an envelope. The O key (O for Octave) causes each note to be played together with the note an octave above (using the same envelope for both notes). In the program the inner REPEAT loop causes the SOUND statement to be played UNTIL the key is no longer pressed or UNTIL a different key is pressed. The INKEY parameter defines the length of time the program is to wait and see if a key is pressed. The value of this parameter has got to be as small as possible, (so playing the keys fast is possible), but greater than the repeat rate at which characters are sent by a continually depressed key. The repeat rate is decreased to its smallest possible value using a *FX call (see *User Guide*). The effect keys are checked by PROCcheckforstops, in between each note being played. A variety of stops could be examined by extending this procedure. The procedure also has to absorb the variable number of characters that will be sent by a stop key due to the increased key repeat rate.

You can define up to four envelope statements and these can be incorporated into a number of effect keys. Some suggestions are:

- single notes with a selected envelope (four possibilities).
- chords can be played with two or three sound statements selecting one of the four envelope statements (eight possibilities) for each note in the chord.
- playing chords where each note in the chord is controlled by a different envelope statement (4x3x2 possibilities per three note chord).
- Adding chanel 0 effects.

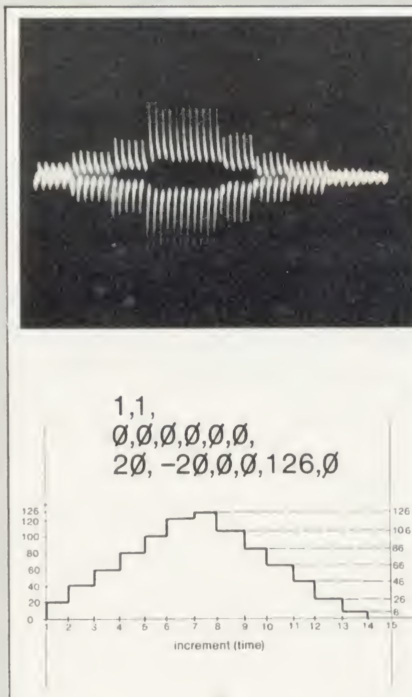


Figure 4. Variation in amplitude controlled by the envelope statement. Oscilloscope trace starts on the third increment

Alternatively, program 2 can be used to experiment with the effect of the amplitude envelope by playing tunes from DATA statements (*Acorn User* December). The code

Program 2. Sets up envelopes from DATA statements

```
 10 tempo = 1
 20 INPUT aa, ad, as, ar, ala, ald
 30 ENVELOPE 1,1, 0,0,0,0,0,0,
             aa, ad, as, ar, ala, ald
 40 REPEAT
 50   READ note, duration
 60   IF note=255 THEN envelope=0
                  ELSE envelope=1
 70   SOUND 1, envelope, note, tempo*duration
 80 UNTIL note=-1
 90
100 DATA ......
```

Table 1.
Envelope parameters for some instruments

aa	ad	as	ar	ala	ald	approx. description
126	-4	0	0	126	100	Electric piano
126	-8	0	0	126	50	Electric guitar
126	-8	-4	-1	126	100	Acoustic piano
126	-10	-5	-2	126	126	Acoustic guitar
63	10	0	-63	63	126	Organ
63	63	0	-63	63	126	Wind instrument

```
10 duration = 2
20 ENVELOPE 1,1, 0,0,0,0,0,0,
            126, -20, -20, -20, 126, 60
30 ENVELOPE 2,1, 0,0,0,0,0,0,
            90, -20, -20, -20, 90, 60
35 ENVELOPE 3,1, 0,0,0,0,0,0,
            20, -20, -20, -20, 126,90
40 FOR bar = 1 TO 16
45   FOR triplet = 1 TO 2
50     FOR note = 1 TO 3
60       IF note=1 THEN envelope = 1 ELSE envelope = 2
70       SOUND 0, envelope, 4, duration
80     NEXT note
90   NEXT triplet
100  FOR note = 1 TO 4
110    SOUND 0, 3, 4, duration*3/2
120  NEXT note
150 NEXT bar
```

Program 3. Rhythmic effects

255 is used to represent rests. This means only two items of information are needed per musical entity (note or rest) in the DATA statement.

Figure 4 is an oscilloscope photograph of an isolated note generated using:

```
ENVELOPE 1, 1,
         0, 0, 0, 0, 0, 0,
         20, -20, 0, 0, 126, 0
```

This is an inverted 'V' envelope taking seven increments to build up and seven to decay, the attack rate being equal and opposite to the decay rate. If this was compressed in the horizontal or time direction so the steps were not so apparent, it would begin to look like an instrumental envelope.

Some amplitude envelopes are now given together with a very approximate subjective description of their sound or effect. All the envelope statements in this article are only suggestions. The emphasis is on relating envelope parameters to the produced sound and in giving frameworks for experimentation. With some imagination and patience you should produce pleasing and original sound.

The envelope parameters in table 1 are meant to be used with t=1. In the top part of the table, percussive envelope values are given, in the bottom part wind instruments' values are suggested. Note that for the wind instruments values of *ald* are greater than *ala* and *ad* is positive. A long slow attack is continued into the decay phase.

We now move on to consider the effect of using two or three sound statements under envelope control. An echo effect can be achieved by using a second sound statement under a different envelope control, but using the same sound channel. A suggesting is:

```
20 ENVELOPE 1,1,
            0,0,0,0,0,0,
            aa,ad,as,ar,ala,ald

30 ENVELOPE 2,1,
            0,0,0,0,0,0,
            aa/2,ad,as,ar,ala/2,ald/2
   .
   .
80 SOUND 1, envelope, note,
   duration * tempo
90 SOUND 1, envelope*2, note,
   tempo * 2
```

The parameters in the echo envelope can be made a function of the main envelope parameters to control the echo effect. Again experiment yourself.

As discussed above, it is not only the transient behaviour of a note that gives it its chracteristic instrumental sound, but its harmonics. We can add harmonics to a program generated note, but only two. Also bear in mind that the BBC tones are not sine waves and that is why, no matter how hard you try, all notes will sound 'electronic'. Now in real harmonic envelopes, not only does the amplitude change as a function of the frequency of the harmonic but so does the attack rate of the harmonic. We can control this easily in a program:

```
20 ENVELOPE 1,1
            0,0,0,0,0,0,
            aa,ad,as,ar,ala,ald
30 ENVELOPE 2,1
            0,0,0,0,0,0,
            aa/2,ad,as,ar,ala/2,ald/2
40 ENVELOPE 3,1
            0,0,0,0,0,0,
            aa/3,ad,as,ar,ala/3,ald/3
   .
   .
90 SOUND 1, envelope, note,
   tempo * duration
100 SOUND 2, envelope*2, note +
   48 tempo * duration
110 SOUND 3, envelope*3, note +
   96, tempo * duration
```

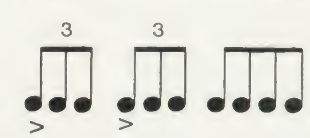
Other simple effects can easily be attained with octave · sound statements if we detune the octaves:

```
80 SOUND 1, envelope, note,
   tempo*duration
90 SOUND 2, envelope note + 50,
   tempo*duration
100 SOUND 3, envelope, note + 97,
   tempo*duration
```

Using a common percussive envelope, this will give the sound of a West Indian steel band – oil drums tuned to octaves but exhibiting less than perfect tuning.

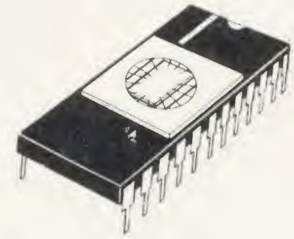
Finally, program 3 demonstrates the use of channel 0 in conjunction with a percussive envelope to produce a rhythm from a monotone percussion instrument. The rhythm is shown in figure 5, and if you don't know what this is from reading the dots then play the program.

Figure 5. Rhythm for program 3



Note also in program 3 the use of two envelope statements to simulate that the emphasis can either be an amplitude change or the note played on another drum. A program like this could be merged into either the tune playing program or the keyboard program to add a rhythm section. This rhythm is intended to show the variations possible within a bar, using emphasis from different envelope statements in conjunction with channel 0, rather than something that Gene Krupa would play!

In the next issue we shall continue with treatment of the pitch envelope and look at some mathematical and syntactical ele-eements of music structure that enable you to get your machine to do something more interesting than playing the ubiquitous 'Greensleeves' from a DATA satement.



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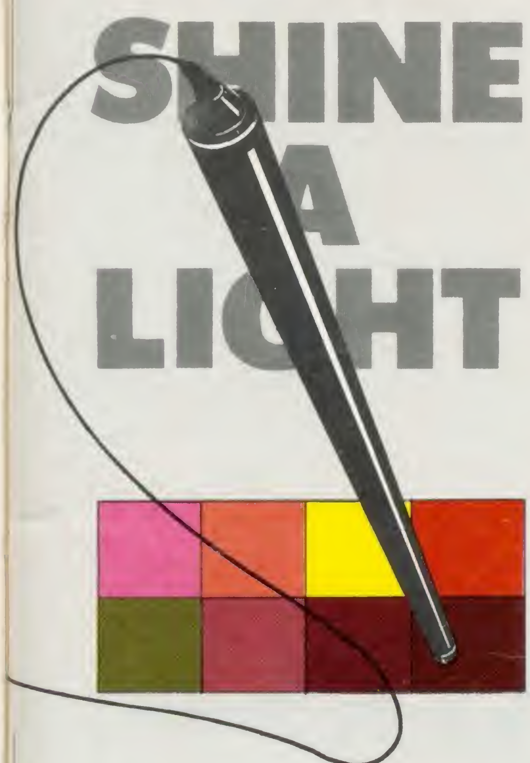
Joe Telford builds a lightpen for £17 and writes the software to run it on the BBC micro – with or without the Tube

SHINE A LIGHT



A typical lightpen picks up light given out by the TV screen. The pen sends an electronic signal into the micro, where circuitry decodes the position on the screen at which the pen is pointing. Software can access this input, tailor it to the screen mode and allow the user to play games, draw and 'paint', design layouts, select multiple choice answers, update and alter information using a menu, or interact with graphic simulations. And these are just a few applications.

There are two main problems to be solved: construction of the hardware, and writing suitable software. Before doing either, look at the input/output facilities of the BBC micro to find a suitable port or input channel. Normally I would go for the user port. However, examining the ADC (analogue to digital converter) port circuitry shows a possible connection.

Figure 1 shows the paddle and lightpen (ADC) connector. Notice that pin 9 is marked LPST B, and this is the light pen strobe input. Our first priority is to ensure a TTL type input goes to this pin when our lightpen is held to an illuminated section of TV screen.

The *RS catalogue* of electronic components, shows a device which can be used: the pin photodiode (RS number 303 292) at £6.33.

The high sensitivity of the pin photodiode allows a range of screen intensities to be received. If the pen does not seem to react to the screen, the remedy is often simply to increase screen brightness on the TV.

The value of this is that a simple circuit can be constructed, which allows a slim biro to be used Figure 2 shows a circuit for the pin photodiode. The tag on the pin photodiode identifies leads 1,2,3 when aligned with its diagram in figure 2.

While constructing a prototype, I decided the pen's facilities would be enhanced if it could move a cursor across the screen. When that cursor was in the correct position, pressing a switch would indicate this to the computer. A keyswitch on the keyboard would do, but this defeated the philosophy of having a self contained lightpen. Hence the touch pad in the prototype circuit.

In addition to the wires from sensor to paddle connector, we take wires to the outside surface of the pen. These are connected to an analogue input and effectively measure skin resistance. Under software control we can make these contacts behave like a switch. Notice also that we have a 100k (100,000 ohm) resistor, which makes a potential divider. We develop a voltage of about 1.8v across the user's finger, when touching the contacts (about the same as a single battery in a torch).

WARNING: Ensure the ADC reference voltage is not at mains potential, and that you do not touch live wires while using the lightpen. Neither the author, *Acorn User* nor Acorn will accept responsibility in the event of an accident involving using mains electricity with this lightpen. It is designed to operate at voltages of 1.8 volts and 5 volts **only**.

Figure 3 shows the constructed lightpen. The connector to the ADC port is a 15 pin 'D' connector available from most BBC micro stockists, RS or Farnells. The connecting wire is five core stranded wire, and about four feet will be needed. Again, any electronics dealer should sell this. The touch sensors can be made from two copper strips (half-inch Veroboard) which after soldering, can be glued on the pen barrel.

Soldering the light sensor is easy, providing you use pliers to dissipate heat from the sensitive pin photodiode (figure 4). Once the leads are soldered they need to be individually insulated with tape.

The pen itself can be any size which allows the light sensor to fit inside its empty barrel. Once the sensors are glued in place, the pen

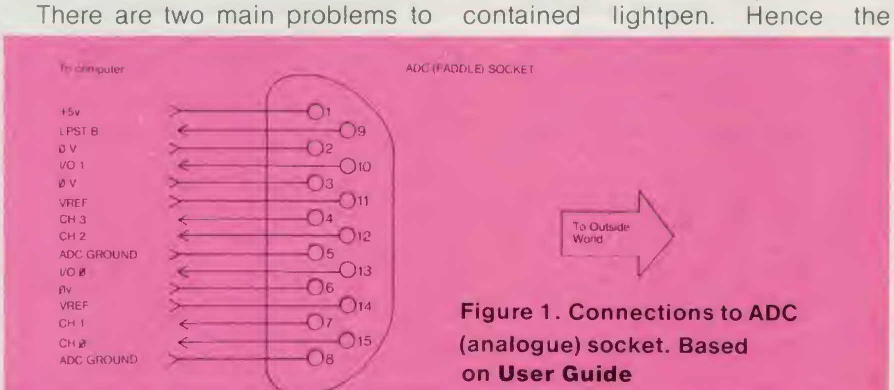


Figure 1. Connections to ADC (analogue) socket. Based on User Guide

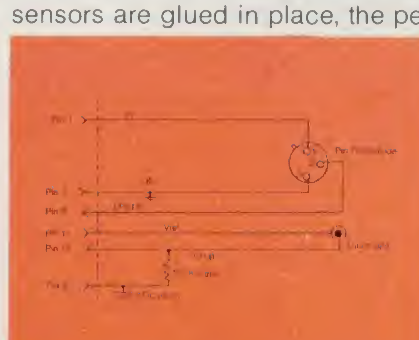


Figure 2. Final prototype design

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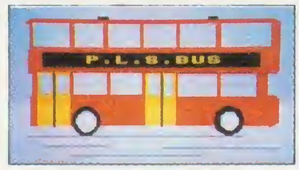

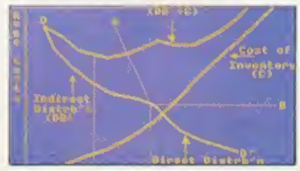

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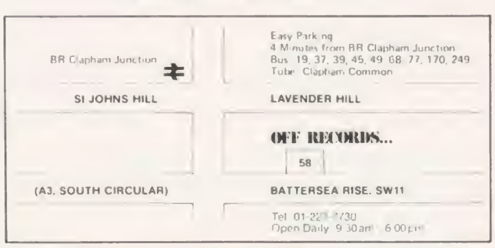

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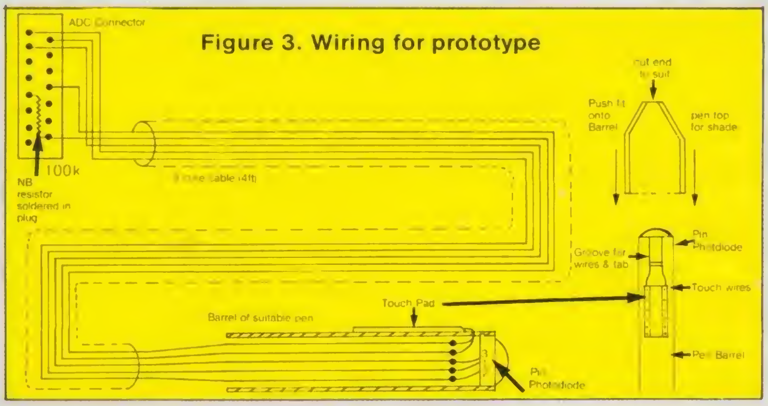

Figure 3. Wiring for prototype

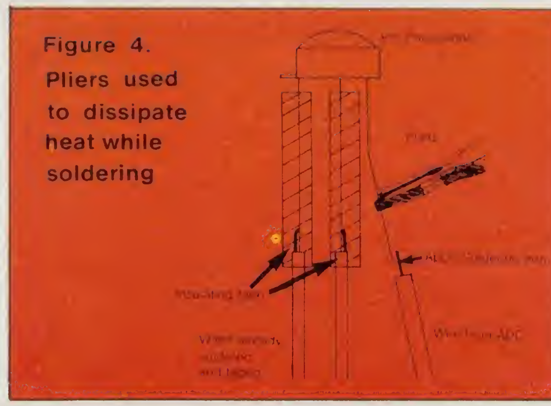

Figure 4. Pliers used to dissipate heat while soldering

cap can act as a shade to improve accuracy. This fits over the light sensor and has its end cut to let in light from the screen.

The total cost of this last pen (buying new equipment):

Order no	Item	Cost	Supplier
303 292	Pin photo-diode	£6.33	RS
140 822	15 pin D plug	£2.61	Farnells
140 841	15 pole D cover	£3.99	Farnells
140 496	5m cable	£1.85	Farnells
	100k ohm ¼ watt resistor	£0.03	Tandy etc.
	Old pen to suit	£0.00	
	+ VAT	£2.22	
	Total	£17.03	

If nothing else, readers can see most commercial lightpens are not tremendously overpriced, although if you made say 100 pens they would each cost about £14.

At this point, we have our light pen to plug into the ADC port, except nothing happens. This is because we have to use software to get at the 'other end' of LPSTB.

The other end is connected to a fairly high powered chip inside the BBC micro. Not, as we might expect, the ADC chip, but the 6845 CRTC. 6845 is the integrated circuit number and CRTC means cathode ray tube controller. This works in combination with the video ULA to control the screen in a number of ways. One of the tasks of the CRTC is to handle the signal picked up by the lightpen and to generate a unique number for each screen location it reads.

The CTRC contains 18 registers numbered 0 to 17. Each is used by the BBC micro in different ways, though we are especially interested in registers 16 and 17 which contain information about the lightpen. Register 16 holds the most significant byte of the location of the lightpen and register 17 holds the least significant byte. Putting them together gives us a number which relates to the position of the lightpen on the screen.

Unfortunately, the 18 registers are not directly memory mapped in the BBC micro. However, page 437 of the *User Guide* gives a hint on how to access the registers which we need.

Location &FE00 is memory mapped to the address register of the CRTC and location &FE00 is memory mapped to the register file of the CRTC. So, if we put a number from 0 to 17 into location &FE00 then location &FE01 effectively becomes the CRTC register indicated by that number.

For example, type:

```
?&FE00=16:P.?&FE01
?&FE00=17:P.?&FE01
```

Readers will see that each line produces a number in the range 0 to 255, ie, a byte-sized number. Together these tell us where the lightpen is pointing. We get numbers from these registers even if the lightpen isn't pointing at the screen, or indeed isn't even plugged in. Type this program:

```
10?&FE00=16:P.?&FE01
20?&FE00=17:P.?&FE01
```

Now plug in the lightpen, hold it about five inches from a 60W bulb and type RUN. The program will print two numbers. Remove the pen from the lamp quickly and type RUN again. The same two numbers should appear.

This indicates the CRTC has memorised the last known pen position. To test the pen with a TV screen, simply LIST the program a couple of times, turn up the brightness and hold the pen on a part of the listing. Type RUN. Two different numbers should appear. Move the pen to another part of the listing and type RUN. Another pair of numbers should appear. If this is the case we are ready to begin writing software. If not, check the connections on the D connector, and the pin photodiode itself.

Program 1 is an essential procedure to run the lightpen. It is called by PROC_quopen which regards the screen as a series of

Program 1. Lightpen procedure

```
1290DEFPROC_quopen
1295LOCAL offset,width,scale
1300offset=1542:width=80:scale=1
1305REPEAT
1310:
1315?&FE00=16:hipen=?&FE01
1320:
1325?&FE00=17:lopen=?&FE01
1330penpos=INT((hipen*256+lopen)-offset)
1335peny=penpos DIV width
1340penx=INT((penpos MOD width)/scale)
1345UNTIL ADVAL(1)/16>100
1350ENDPROC
```

Table 1. Contents of 'offset' for each mode

Mode	Offset
7	10248
6	3076
5	2820
4	2820
3	2054
2	1542
1	1542
0	1542

Table 2. Contents of 'width' for each mode

Mode	Width	Maximum resolution
7	40	single character
6	40	single character
5	40	half character
4	40	single character
3	80	single character
2	80	quarter character
1	80	half character
0	80	single character

Table 3. Contents of 'scale' for each screen mode

Mode	Scale= (to access single characters)
7	1
6	1
5	2
4	1
3	1
2	4
1	2
0	1

character sized locations as for text handling. It returns the position of the lightpen in two variables, *penx* and *peny*. These can be used in the TAB function. If for example the lightpen is pointing at line 7, character position 14, then *penx* will contain 14 and *peny* will hold 7. Hence a program line:

PRINT TAB(penx,peny);"P"

will print a 'P' on the screen in front of the lightpen.

The procedure uses the special variables 'offset' and 'width'. The first is essential to find the top left screen position. Because of hardware timings etc, when the CRTC returns the pen location, it is between 1000 and 10248 higher than expected depending on the screen mode. To correct this, we subtract the 'offset' value from the combined contents of CRTC registers 16 and 17. This is done in line 1330. Alter line 1295 for each mode using table 1, which lists the contents of 'offset' for each screen mode.

The next special variable which users must set up for each screen mode is 'width'. This is the resolution of the lightpen across the width of the screen, and table 2 shows this for each mode. The last of the special variables is 'scale'. This enables the lightpen to access the screen in whole characters. Again, 'scale' needs setting for each mode (table 3).

Lines 1305 and 1345 form a loop which allows the CRTC to continually update *penx* and *peny*. This continues until a touch pad is pressed and is tested by:

UNTIL ADVAL(1)/16>100

The value 100 may need adjusting as it is an analogue of skin resistance. A suitable value should be between 50 and 300, sensitivity increasing as the value decreases.

The idea of the touch pad is that the pen can be held against the screen until the user is confident the pen is correctly place. Then, pressure on the pad will conclude the procedure, and return the latest values of *penx* and *peny* to the body of the program. It acts as a safety catch to prevent spurious garbage entries.

Program 1 is the procedure on which other programs included in this issue are based. However, the lightpen is a device which will still be used when readers upgrade to a second processor at the other end of the Tube. Unfortunately, the region of I/O memory in the BBC micro will not move along the Tube, and so such commands as:

P.?%FE01

may print a value, but certainly not the value of the CRTC register file.

Program 2 performs just as program 1 except it is Tube compatible. The lines which allow this compatibility are 1040 to 1075. An explanation of these is as follows:

1040 *FX151,0,16

means place 16 in location 0 of page &FE (*FX151 means write to page &FE). It is identical to ?&FE00 = 16 except it is Tube compatible.

1050 A%=&96:X%=1 means set A% to &96 and X% to 1 in preparation for calling a machine code routine. Don't worry! Acorn have written the routine for us.

1055 hipen=(USR(&FFF4)DIV&FFFF) AND &FF calls a machine code subroutine which places A% in the accumulator and X% in the X-register of the 6502. The &FFF4 start location of the subroutine indicates this is an OSBYTE (operating system byte) call, and with parameters A%=&96 and X%=1 it reads the contents of location 1 of page &FE in the I/O processor (BBC micro). The result of the USR statement is a number which is made up of four bytes: (i) program status register, (ii) Y register, (iii) X register, (iv) the accumulator.

The rest of the line:

DIV &FFFF) AND &FF

extracts the single byte we need, that in the Y register.

Lines 1060 to 1075 perform the same functions as 1040 to 1055 except they produce the contents of 'lopen'.

The procedure is set for a particular screen mode by line 1010. The three most common

Program 2. Tube compatible

```
1000DEFPROC_quopen
1010LOCAL offset,width,scale
1020offset=1542:width=80:scale=1
1030REPEAT
1040*FX151,0,16
1050A%=&96:X%=1
1055hipen=(USR(&FFF4)DIV &FFFF) AND &FF
1060*FX151,0,17
1070A%=&96:X%=1
1075lopen=(USR(&FFF4)DIV &FFFF) AND &FF
1080penpos=INT((hipen*256+lopen)-offset)
1090peny=penpos DIV width
1100penx=INT((penpos MOD width)/scale)
1110UNTIL ADVAL(1)/16>100
1120ENDPROC
```

modes I have used are 7,4, and 2. From the tables we can see these modes require the following amendments to line 1010:

1010offset=10248:width=40:scale=1 for mode 7
1010offset=2820:width=40:scale=1 for mode 4
1010offset=1542:width=80:scale=4 for mode 2

The second version of the procedure relies on *FX calls not available before OS 1.00, so I will refer to the first version of the procedure from here onward.

Because the pen needs screen light, there are two techniques which can be used. The first is to light up only the parts of the screen which contain information for the pen to work on. For example the message:

PEN HERE TO GO ON >@<

is followed by a target (a bright character) at which the pen must be aimed.

This approach is useful in a question and answer session, or in a program where the lightpen selects from a menu. In a game of computer draughts however, the sight of 24 targets might be more than a trifle offputting.

The second technique is best used after experimenting with the target approach. In this approach the whole of the screen is brightened, normally by CLS after VDU19,0,7,0;0;0; The whole screen can then be accessed by the lightpen, and software would decide which inputs were valid. This allows game playing programs, freehand design, painting, drawing and so on.

Program 3. Relies on the target approach

```
10MODE7
20CLS
30PRINTTAB(10,5);"PEN IS AT"
40x=RND(39):y=RND(10)+10
50PRINTTAB(x,y);CHR$(255)
60PROC_quopen
70VDU7
80PRINTTAB(10,7) penx peny
90PRINTTAB(x,y);CHR$(32)
100t=TIME+100
110REPEAT UNTIL TIME>t
120GOTO40
1000DEFPROC_quopen
1005LOCAL offset,width,scale
1010offset=10248:width=40:scale=1
1015REPEAT
1020:
1025?&FE00=16:hipen=?&FE01
1030:
1035?&FE00=17:lopen=?&FE01
1040penpos=INT((hipen*256+lopen)-offset)
1045peny=penpos DIV width
1050penx=INT((penpos MOD width)/scale)
1055UNTIL ADVAL(1)/16>100
1060ENDPROC
```

Program 4. Background approach

```
10MODE4
20VDU19,0,7,0;0;0;19,1,0,0;0;0;:CLS
30PRINTTAB(10,5);"PEN IS AT"
40PROC_quopen
50VDU7
60PRINTTAB(4,7)penx peny
70PRINTTAB(penx,peny);CHR$(42)
80t=TIME+100
90REPEAT UNTIL TIME>t
100GOTO40
110REPEAT UNTIL TIME>t
120GOTO40
1000DEFPROC_quopen
1005LOCAL offset,width
1010offset=2820:width=40:scale=1
1015REPEAT
1020:
1025?&FE00=16:hipen=?&FE01
1030:
1035?&FE00=17:lopen=?&FE01
1040penpos=INT((hipen*256+lopen)-offset)
1045peny=penpos DIV width
1050penx=INT((penpos MOD width)/scale)
1055UNTIL ADVAL(1)/16>100
1060ENDPROC
```

Program 3 demonstrates the target approach by randomly choosing targets in the lower half of a mode 7 screen. When the lightpen is held to a target and the touch sensor pressed, the location of the target is printed. To avoid auto repeating by people who are slow to remove their fingers from touch pads, I have included line 70 which is intended to give the user a positive feedback on pressing the touch sensor. Lines 100 and 110 also ensure the user has one second's grace, before GOTO40 begins to auto repeat.

Users will find the sound cue useful, and with practice can do away with the delay loop altogether. The only other point about this program is that it needs the light pen procedure given earlier. For mode 7, line 1010 of the procedure will need altering to:

offset=10248:width=40:scale=1

Program 4 demonstrates the background approach by allowing the user to point the pen anywhere on the mode 4 screen. When the lightpen is held to the screen and the touch sensor pressed, the location of the target is printed plus an asterisk in the actual position. This program uses the same approach to prevent users from auto repeating. The program again needs the lightpen procedure given earlier. For mode 4, line 1010 of the procedure will need altering to:

offset=2820:width=40:scale=1

I hope to continue the use of the light-pen into drawing, painting and general design. Readers who do not feel able to construct either design from this article should be able to buy one from a number of sources, including Acorn. Components from RS and Farnells catalogues may be ordered through electronic dealers or TV repair shops.

- *Next month; how fast does a disc drive?*

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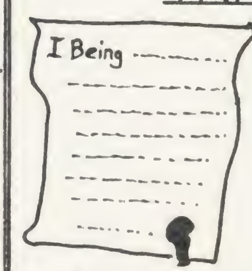

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OXO BY LIGHTPEN

THIS program demonstrates the use of the lightpen in a game format, can be used as a basis for further development, for example to make the computer play against you. It relies on the 'background' technique. Players have to input their names from the keyboard, for convenience, although all input after this is by lightpen.

```
10REM************************
20REM*                      *
30REM*    LIGHT PEN OXO     *
40REM*                      *
50REM* (c) J Telford  1982  *
60REM*                      *
70REM************************
80*TV0,1
90:
100REM SET MODE 4 BLACK ON WHITE
110:
120MODE4
130VDU19,0,7,0;0;0;19,1,0,0;0;0;
140:
150 REM LARGE X AND O
160:
170VDU23,227,255,0,0,0,0,0,0,0
180VDU23,228,0,0,0,0,0,0,0,255
190VDU23,229,1,1,1,1,1,1,1,1
200VDU23,230,128,128,128,128,128,
  128,128,128
210VDU23,224,1,2,4,8,16,32,64,128
220VDU23,225,128,64,32,16,8,4,2,1
230VDU23,226,129,66,36,24,24,36,66,129
240:
250REM SPACE FOR PLAYING BOARD AND
260REM AND 2 SYMBOLS X & O
270:
280DIM board(3,3),Ch$(2)
290:
300REM PUT X AND O INTO stores
310:
320DATA 225,32,224,10,8,8,8,32
330DATA226,32,10,8,8,8,224,32,225
340Ch$(0)="":FORI%=1 TO 17
350READ data
360Ch$(0)=Ch$(0)+CHR$(data):NEXT
370DATA224,227,225,10,8,8,8,230,32
380DATA229,10,8,8,8,225,228,224
390Ch$(1)="":FORI%=1 TO 17
400READ data
410Ch$(1)=Ch$(1)+CHR$(data):NEXT
420:
430REM FINAL SET UP
440REM F= Player to go
450REM lx,ly = last location of pen
460REM win= tests for win/draw
470REM ng = number of goes
480:
490F=0
500DIM name$(2)
510PROC_names
520CLS:PROC_Board
530lx=0:ly=0
540win=0:ng=9
550:
560REM Now repeat for 9 goes
570REM or until a winner
580:
590REPEAT
600:
610REM get Lp input from
620REM correct player.
630:
640PROC_go
650:
660REM 1 second delay to prevent
670REM auto repeat.
680:
690time=TIME+100
700REPEAT UNTIL TIME>time
710:
720REM Now check for win
730:
740PROC_check
750:
760REM decrement no of goes left
770:
780ng=ng-1
790:
800REM If at end then Win=-1
810REM to indicate a draw
820:
830IFng=0 AND win = 0 win=-1
840IF win > 0 THEN PROC_win
850IF win = -1THEN PROC_draw
860:
870REM If the program gets here
880REM then win = 0
890REM IE keep going
900:
910UNTIL win
920:
930REM The game is over check for
940REM another go.
950:
960PRINT TAB(5,26);
970PRINT"Pen to  { }  for another go."
980REPEAT:PROC_quopen
990UNTIL penx=15 AND peny=26
1000:
1010REM Go back to beginning
1020:
1030VDU7:GOTO 520
1040:
1050REM Draw Board and fill array
1060:
1070DEFPROC_Board
1080MOVE336,320:DRAW336,864
1090MOVE528,320:DRAW528,864
1100MOVE132,496:DRAW704,496
1110MOVE132,688:DRAW704,688
1120FOR J%= 1 TO 3
1130FOR I%= 1 TO 3
1140board(J%,I%)=-9
1150NEXT:NEXT
```

```
1160ENDPROC
1170:
1180REM copy array to screen
1190:
1200DEFPROC_printboard
1210FOR J%= 1 TO 3
1220FOR I%= 1 TO 3
1230IFboard(J%,I%)=-9 THEN 1260
1240PRINTTAB(I%*6,J%*6);
1250PRINTCh$(board(J%,I%))
1260NEXT:NEXT
1270ENDPROC
1280:
1290REM get players names
1300:
1310DEFPROC_names
1320CLS:REPEAT:PRINTTAB(5,10);
1330PRINT"Who is ";Ch$(0);" ";
1340INPUTname$(0)
1350UNTIL LEN(name$(0))>1
1360CLS:REPEAT:PRINTTAB(5,10);
1370PRINT"Who is ";Ch$(1);" ";
1380INPUTname$(1)
1390UNTIL LEN(name$(1))>1
1400CLS:PRINTTAB(5,20);
1410:
1420REM get pen location to start
1430:
1440PRINT"Pen here to begin.  { }"
1450REPEAT:PROC_quopen
1460UNTIL penx=27 AND peny=20
1470VDU7
1480ENDPROC
1490:
1500REM get each players go from
1510REM Lp.
1520:
1530DEFPROC_go
1540PRINTTAB(5,2);STRING$(30," ")
1550PRINTTAB(5,2);name$(F);"'s go"
1560REPEAT:PROC_quopen
1570UNTIL INT(penx/6) > 0 AND
   INT(penx/6)<4 AND INT(peny/6)>0 AND
   INT(peny/6)<4
1580IF INT(peny/6)=ly AND
   INT(penx/6)=lx GOTO1560
1590IF board(INT(peny/6),
   INT(penx/6)) = -9
   board(INT(peny/6),INT(penx/6)) =
   F :SOUND1,-15,50*(F+1),8 :GOTO1620
   ELSE SOUND0,-15,106,8
1600ly=INT(peny/6):lx=INT(penx/6)
1610GOTO1540
1620PROC_printboard
1630:
1640REM move to next player
1650:
1660F=1-F
1670REM copy this go into last go
1680REM locations
1690:
1700ly=INT(peny/6):lx=INT(penx/6)
1710ENDPROC
1720:
1730REM Check for win by each
1740REM Player. horizontal,
1750REM Vertical, diagonal.
1760:
1770DEFPROC check
```

```
1780t=0:FOR I%=1 TO 3
1790t = t+board(1,I%)
1800NEXT:IF t=0 win=1:ENDPROC
1810IF t=3 win=2:ENDPROC
1820t=0:FOR I%=1 TO 3
1830t = t+board(2,I%)
1840NEXT:IF t=0 win=1:ENDPROC
1850IF t=3 win=2:ENDPROC
1860t=0:FOR I%=1 TO 3
1870t = t+board(3,I%)
1880NEXT:IF t=0 win=1:ENDPROC
1890IF t=3 win=2:ENDPROC
1900t=0:FOR J%=1 TO 3
1910t = t+board(J%,1)
1920NEXT:IF t=0 win=1:ENDPROC
1930IF t=3 win=2:ENDPROC
1940t=0:FOR J%=1 TO 3
1950t = t+board(J%,2)
1960NEXT:IF t=0 win=1:ENDPROC
1970IF t=3 win=2:ENDPROC
1980t=0:FOR J%=1 TO 3
1990t = t+board(J%,3)
2000NEXT:IF t=0 win=1:ENDPROC
2010IF t=3 win=2:ENDPROC
2020t=0:FOR J%=1 TO 3
2030t = t+board(J%,J%)
2040NEXT:IF t=0 win=1:ENDPROC
2050IF t=3 win=2:ENDPROC
2060t=0:FOR J%=1 TO 3
2070t = t+board(J%,4-J%)
2080NEXT:IF t=0 win=1:ENDPROC
2090IF t=3 win=2:ENDPROC
2100ENDPROC
2110:
2120REM incase of a win.
2130:
2140DEFPROC_win
2150PRINTTAB(5,2);STRING$(30," ")
2160PRINTTAB(5,2);name$(win-1)
   " is the Winner"
2170FOR L=1 TO 5:FOR S=50 TO 100
2180SOUND&11,-15,S,2
2190NEXT:SOUND1,0,0,8
2200NEXT
2210ENDPROC
2220:
2230REM In case of a draw
2240:
2250DEFPROC_draw
2260PRINTTAB(5,2);STRING$(30," ")
2270PRINTTAB(5,2);"A draw!"
2280FOR L=1 TO 5:FOR S=0 TO 50
2290SOUND&11,-15,S,2
2300NEXT:SOUND1,0,0,8:NEXT
2310ENDPROC
2320:
2330REM The lightpen Procedure
2340:
2350DEFPROC_quopen
2360LOCAL offset,width,scale
2370offset=2820:width=40:scale=1
2380 REPEAT
2390?&FE00=16:hipen=?&FE01
2400?&FE00=17:lopen=?&FE01
2410penpos=INT(hipen*256+lopen-offset)
2420peny=penpos DIV width
2430penx=INT((penpos MOD width)/scale)
2440 UNTIL ADVAL(1)/16>100
2450ENDPROC
```


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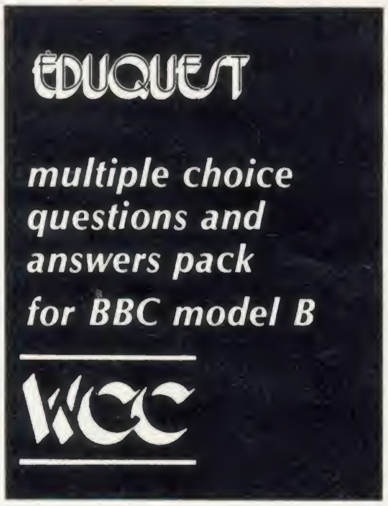

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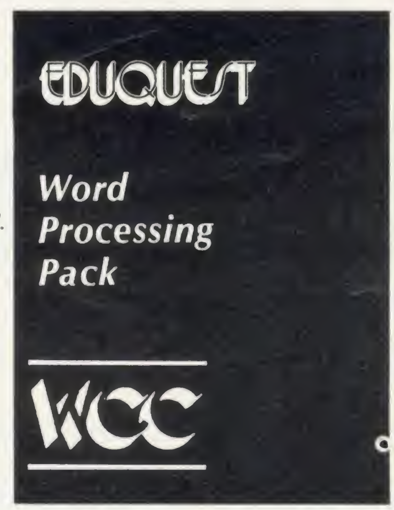

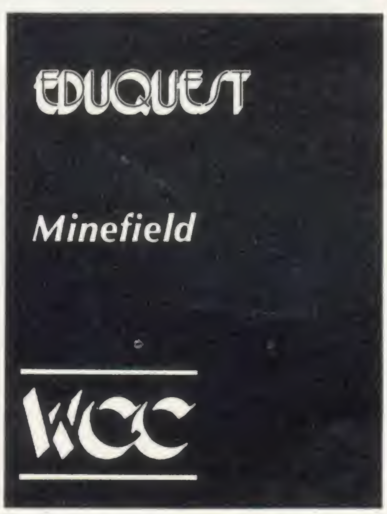

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MULTI-CHOICE

This program is a multiple choice quiz. It contains 10 questions relating to the BBC micro. All input during the program is by lightpen and readers will note the use of sound cues for correct/incorrect answers.

As the number of BBC micros in schools is continually increasing, I should mention that teachers who wish to use this sort of program must give adequate thought to the data to be employed. The incorrect answers (called distractors) need to be produced so they are believable, and should always indicate the problem experienced by the child who gives that distractor as an answer. They should also statistically attract a percentage of children answering the test.

The first thing to change would be the title on lines 520 and 530. The only other amendments would be to changing the data, which begins at line 1490. To change the data, simply delete from 1490 to the end of the program. Next rewrite the data lines in order 'question', 'answers', 'correct answer number'; eg:

```
1490 DATA"This is Qu 1"
1500 DATA"ans 1","ans 2"
1510 DATA"ans 3","ans 4"
1520 DATA"ans 5",3
```

Note the 3 indicates that answer 3 is correct.

Do this for each of the questions as needed. The last DATA line must be DATA"END". The program will automatically score for quizzes of any number of questions.

```
  10REM********************
  20REM*                   *
  30REM* MULTI-CHOICE QUIZ *
  40REM*                   *
  50REM*   FOR LIGHT PEN   *
  60REM*                   *
  70REM*  J.TELFORD  1983  *
  80REM*                   *
  90REM*********************
 100MODE7
 110REM Set error checking
 120 ON ERROR GOTO300
 130REM Startup Program
 140DIM yloc(5),answer$(5)
 150REPEAT
 160RESTORE
 170PROC_setup
 180PROC_title
 190REM Loop through questions
 200REPEAT
 210PROC_getquestion
 220IFq$="END" DONE=-1:GOTO260
 230PROC_displayquestion
 240PROC_getanswer
 250PROC_checkanswer
 260UNTIL DONE
 270PROC_score
 280UNTIL FNagain(T$)="NO"
 290CLS:PRINT'"Bye":END
 300CLS:REPORT:PRINT" at ";ERL
 310PRINT'"Bye":END
 320:
 330REM NOW FOR PROCS
 340:
 350REM Procedures start here.
 360DEFPROC_setup
 370CLS
 380FOR J% = 0 TO 5
 390READ yloc(J%)
 400NEXT
 410no_of_questions=0
 420no_correct=0
 430DONE = 0
 440red$=CHR$(129)
 450green$=CHR$(130)
 460yellow$=CHR$(131)
 470target$=CHR$(255)
 480ENVELOPE1,0,2,-2,2,6,12,6,127,0,0,
   -127,126,0
```

```
 490ENDPROC
 500:
 510DEFPROC_title
  "Multiple Choice Quiz"
 520PRINTTAB(9,10);yellow$;
 530PRINTTAB(10,12);yellow$;
  "For the BBC Micro."
 540PRINTTAB(9,18);"Pen here to start
   ]"target$;"["
 550REPEAT:PROC_quopen
 560UNTIL penx=29 AND peny=18
 570VDU7
 580ENDPROC
 590:
 600DEFPROC_getquestion
 610READ q$:IF q$="END" ENDPROC
 620FOR J%=1 TO 5
 630READanswer$(J%)
 640NEXT
 650READ correctanswer
 660ENDPROC
 670:
 680DEFPROC_displayquestion
 690CLS
 700no_of_questions=no_of_questions+1
 710PRINT'red$;"Question No: ";
 720PRINT;no_of_questions;TAB(20);
 730PRINT"Score: ";no_correct
 740PRINTred$;STRING$(38,"_")
 750PRINTTAB(0,yloc(0));q$
 760FOR J%= 1 TO 5
 770PRINTTAB(0,yloc(J%));"]";target$;"["
 780PRINTTAB(5,yloc(J%));yellow$;
 790PRINTanswer$(J%)
 800NEXTJ%
 810PRINTTAB(0,18);"Pen to line of
   correct answer."
 820ENDPROC
 830:
 840DEFPROC_getanswer
 850REPEAT:PROC_quopen
 860UNTIL penx<3 AND(peny>=yloc(1)
   AND peny<=yloc(5))
 870VDU7
 880ENDPROC
 890:
 900DEFPROC_checkanswer
 910IF yloc(correctanswer)=peny
   THEN PROC_correct ELSE PROC_wrong
```

```
920PROC_cont
930ENDPROC
940:
950DEFPROC_correct
960SOUND1,1,149,8
970no_correct=no_correct+1
980PRINTTAB(0,20);green$;
  "That was correct"
990ENDPROC
1000:
1010DEFPROC_wrong
1020SOUND0,-12,106,8
1030PRINTTAB(0,20);red$;"The correct
   answer was:-"
1040PRINTred$;answer$(correctanswer)
1050ENDPROC
1060:
1070DEFPROC_cont
1080PRINTTAB(5,23);"Pen here to go on
   ]";target$;"[";
1090REPEAT: PROC_quopen
1100UNTIL penx=24 AND peny=23
1110VDU7
1120ENDPROC
1130:
1140DEFPROC_score
1150CLS:PRINT''''yellow$"You scored ";
1160PRINT;no_correct*100/no_of_questions;
1170PRINT"%"
1180ENDPROC
1190:
1200DEFFNagain(T$)
1210PRINTTAB(5,10);green$"Another go?"
1220PRINTTAB(5,12)"]";target$;"[   YES"
1230PRINTTAB(5,14)"]";target$;"[   NO"
1240REPEAT:PROC_quopen
1250UNTIL penx=6 AND
  (peny = 12 OR peny = 14)
1260VDU7
1270 IF peny =12 THEN ="YES" ELSE ="NO"
1280:
1290DEFPROC_quopen
1300LOCAL offset,width,scale
1310offset=10248:width=40:scale=1
1320REPEAT
1330:
1340?&FE00=16:hipen=?&FE01
1350:
1360?&FE00=17:lopen=?&FE01
1370penpos=INT((hipen*256+lopen)-offset)
1380peny=penpos DIV width
1390penx=INT((penpos MOD width)/scale)
1400UNTIL ADVAL(1)/16>100
1410ENDPROC
1420:
1430REM Y-locations of answer lines
1440:
1450DATA4,8,10,12,14,16
1460:
1470REM Each question
1480:
1490DATA"What is the type of main
   processor fitted to the BBC  micro?"
1500DATA"The 6800","The 8080"
1510DATA"The 6502","The Z80"
1520DATA"The 6522",3
1530:
1540DATA"What is the type of I/O
   port used by the BBC Micro?"
1550DATA"The 6205 VIA","The 8255 PIA"
1560DATA"The 8255 VIA","The 6522 VIA"
1570DATA"The 6522 PIA",4
1580:
1590DATA"Which Chip allows the
   use of the Light  Pen?"
1600DATA"The 6845 CRTC"
1610DATA"The D7002C ADC"
1620DATA"The 74LS00 gate"
1630DATA"The 6522 VIA"
1640DATA"The Video ULA",1
1650:
1660DATA"Which Area of Memory is
   assigned to Controlling I/O?"
1670DATA"Fred","Jim","John","Ethel"
1680DATA"Shiela",5
1690:
1700DATA"If we were controlling an
   extra VIA from the BBC Micro,
   which socket would
   we connect to?"
1710DATA"Disc interface","User port"
1720DATA"Printer port",1M Hz Bus"
1730DATA"The Tube",4
1740:
1750DATA"Using the RS432 Port,
   what is the
   fastest transmission
   speed available?"
1760DATA"1200 Baud","19200 Baud"
1770DATA"9600 Baud","1M Hz","2M Hz"
1780DATA2
1790:
1800DATA"Which of the following EPROMS
   cannot be used in the BBC Micro?"
1810DATA"2732 4K","2764_INTEL 8K"
1820DATA"2764_HITACHI 8K"
1830DATA"27128 16K","2716 2K",5
1840:
1850DATA"What is the current level of
   Operating  System for the BBC Micro?"
1860DATA"OS V1.20","OS V2.00"
1870DATA"OS V1.00","OS V0.10"
1880DATA"OS V0.01",1
1890:
1900DATA"Which Software Pack is not
   available on the BBC Micro?"
1910DATA"LISP","PILOT","FORTH"
1920DATA"WORDPROCESSING","BASIC",2
1930:
1940DATA"Who is Education Manager
   for ACORN?"
1950DATA"Tony Quinn"
1960DATA"Herman Hollerith"
1970DATA"Shirley Williams"
1980DATA"John Coll"
1990DATA"Jane Fransella",4
2000:
2010DATA"END"
```

INDIRECT ADDRESSING

Tony Shaw and John Ferguson show how to work with a variable or computed address in memory

When dealing with large tables or lists of data it is useful to have instructions that allow you to read from or write to a variable or computed address. Indexed addressing, where the position of the data is calculated by adding the contents of the X or Y register to a base address, is helpful, but is restricted to a range of 256 locations about the base address. For example, LDA &2000, X would only allow access to locations between &2000 and &20FF.

The technique of indirect addressing solves this, and allows you to work with a 'variable' address anywhere within memory.

The simplest instruction that uses the technique is the indirect JMP. Although not involved with reading or writing data to memory it serves as a useful introduction. Like the normal absolute JMP instruction, the indirect JMP transfers program control to a new position in memory. However, the address that follows the indirect JMP is not the address the program jumps to. Instead it acts as part of a pointer or vector to the final location. Confused? The example of JMP(&1800) should help. Note how the brackets are used in assembly language to distinguish the JMP indirect from the JMP absolute instruction.

The address program control passes to is stored in two memory locations – &1800 and &1801. Figure 1 shows how the first location contains the low byte of the address (ADL) and the second the high byte (ADH).

Program 1a shows a simple routine that uses the JMP indirect instruction as part of a program loop to fill the screen with the letter A. Memory locations &2150 and &2151 act as vectors pointing to the start of the program at &2000. Program 1b shows a small but useful refinement used to load the ADL and the ADH bytes of the label START into the indirection pointers vector and vector +1. The low byte is obtained in line 70 using the MOD function to obtain the remainder when START (&2000) is divided by 256. In a similar manner line 90 finds the high byte of START using DIV to give the whole number part of the division.

But why bother with complicated indirect jumps when an absolute jump would perform the same job? In the simple example above there is no advantage. However, one application where indirect jumps do prove useful is in maintaining a fixed entry point to a subroutine that can be 'redirected' to perform different tasks. For example, the operating system routine OSWRCH (&FFEE) is used by the BBC micro to write characters on the screen. The first instruction in this routine is JMP (&020E) with an indirect jump through WRite CHaracter Vectors

a
```
  10 MODE7
  20 REM JUMP INDIRECT INSTRUCTION
  30 OSASCI=&FFE3
  40 VECTOR=&2150
  50 P%=&2000
  60[
  70.START LDA #00 \LOW BYTE OF "START"
  80       STA VECTOR
  90       LDA #&20 \HIGH BYTE OF "START"
 100       STA VECTOR+1
 110       LDA #ASC("A") \ASCII "A"
 120       JSR OSASCI    \PRINT "A"
 130       JMP (VECTOR)  \BACK TO START
 140]
 150 END
>RUN
2000
2000 A9 00    .START LDA #00 \LOW BYTE OF "START"
2002 8D 50 21 STA VECTOR
2005 A9 20    LDA #&20 \HIGH BYTE OF "START"
2007 8D 51 21 STA VECTOR+1
200A A9 41    LDA #ASC("A") \ASCII "A"
200C 20 E3 FF JSR OSASCI    \PRINT "A"
200F 6C 50 21 JMP (VECTOR)  \BACK TO START
```

b
```
 70.START LDA #START MOD 256 \LOW BYTE OF "START"
 80       STA VECTOR
 90       LDA #START DIV 256 \HIGH BYTE OF "START"
100       STA VECTOR+1
```

Program 1. (a) Example using indirect jump
(b) Using MOD and DIV to find ADH and ADL of label

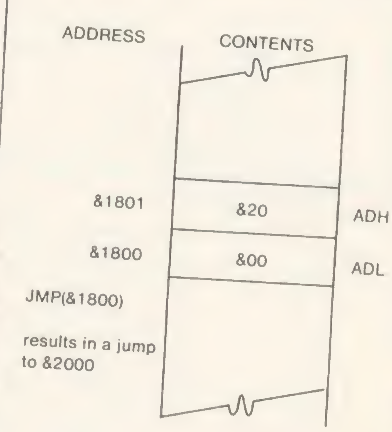

figure 1. The Jump Indirect Instruction

&020E (WRCHV). Whenever the operating system wishes to alter the effect of OSWRCH, eg to direct output to a printer or modem, all it has to do is to change the contents of the vectors in RAM to point to a different output handling routine. The entry point to the subroutine OSWRCH remains fixed.

Program 2 uses this technique to convert all upper case characters sent to the screen to lower case. It starts by altering WRCHV and WRCHV+1 to point to a new output handler routine starting at OUT. The new routine intercepts all characters from the operating system and converts those with ASCII codes > &40 to lower case. (A close look at the ASCII code table shows this is easily done by forcing bit five in the ASCII code to a one). After the change, characters are then allowed to pass down the normal output channel to the screen.

Upon executing the routine all future operations with the screen will produce lower case characters. The sample Basic program shows a typical display with Basic keywords in lower case. To return to normality, press the BREAK key and the operating system initialisation program will restore the original values to WRCHV and WRCHV+1.

Unfortunately, 'straightforward' indirect addressing is not available for LDA, STA and CMP instructions. Instead the microprocessor uses a more complex form of indirect addressing that involves either the X or Y index register.

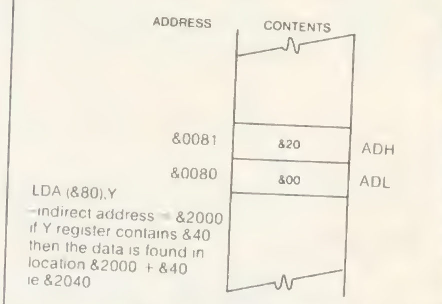

figure 2 Indirect Indexed Addressing

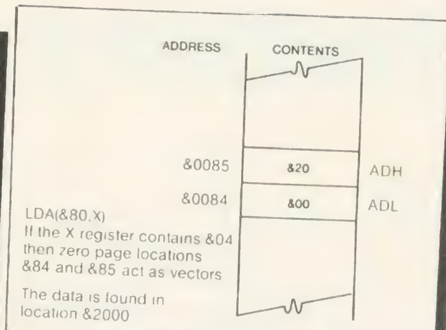

figure 3 Indexed Indirect Addressing

Indirect indexed is really three modes in one combining indirect addressing together with zero page and indexed – Y. It sounds horrific, but let's examine a typical instruction. Like the indirect jump, brackets are used in assembly language to define indirect addressing. Hence:

LDA (&80)

would mean 'load the accumulator with the contents of the memory location pointed to by the contents of zero page locations &0080 and &0081'. Just as with the indirect jump instruction &80 contains the ADL and &81 contains the ADH.

Regrettably this simple instruction does not exist. The real instruction takes the form:

LDA (&80), Y

with the contents of the Y register added to the address found in the vectors (figure 2). The vectors *must* lie in zero page.

Indexed indirect is again a combination of three addressing modes, but this time the X register is used. A second difference lies in the order in which the modes are applied. In the previous case the indirect address was evaluated before the index was added on. With this mode the indexing is performed on the zero page vectors before the indirect address is evaluated.

The example of LDA(&80,X) should help. If the X register contains four then locations &0084 and &0085 would be used as the ADL and ADH vectors to the final location containing the data (figure 3).

For many applications the added complexity of using the X or Y registers is not required. With both indirect indexed and indexed indirect the programmer can read or write data to any location within memory by merely altering the contents of the zero page pointers. Program 3 illustrates the technique using zero page pointers POINT and POINT+1 to store characters entered from the keyboard in an

```
10 REM CHANGING UPPER TO lower CASE
20 REM BY ALTERING "WRITE CHARACTER VECTORS"
30 OSWRCH=&FFEE
40 WRCHV=&020E:REM WRITE CHARACTER VECTORS
50 FOR PASS=0 TO 3 STEP 3
60 P%=&0D01
70[OPT PASS
80.START LDA #OUT MOD 256 \POINT TO LOW BYTE
90       STA WRCHV        \OF NEW OUTPUT ROUTINE
100      LDA #OUT DIV 256 \POINT TO HIGH BYTE
110      STA WRCHV+1      \OF NEW OUTPUT ROUTINE
120      RTS              \BACK TO BASIC
130.OUT  CMP #&40  \CONVERT CODES > &40
140      BCC MISS
150      ORA #&20  \SET BIT 5 ie CHANGE TO LOWER CASE
160.MISS JMP &E098 \DOWN NORMAL CHANNEL TO SCREEN
170]
180 NEXT PASS
190 CALL START
```

Program 2. Redirecting OSWRCH to produce lower case characters

```
>list
   10 for n=1 to 10
   20 print"fido"
   30 next n
>run
fido
fido
fido
fido
fido
fido
fido
fido
fido
fido
```

Sample screen output

ASCII text file starting at &2000. The program begins by initialising X to zero and setting the vectors to point to the first location in the file (&2000). The operating system routine OSRDCH is used to obtain a character from the keyboard which is then sent via OSASCI to the screen before line 160 stores it in the file. Although indexed indirect addressing was used, indirect indexed addressing with Y = 0 would perform the same job.

An underline character (ASCII &5F) marks the end of the file returning control to Basic. Lines 190 to 220 increment the storing pointers to point to the next available location in the file and ensure POINT+1 is only incremented whenever the low order vector reaches zero. (Note – no limitation is made on the maximum size of the text file.)

When assembled the routine sits in page D out of the way of Basic. Line 40 configures function key one to execute the program. Program 4 shows a short Basic program that can be used to display the text file.

Finally, the routine given in program 5 enables the BBC micro to execute a series of commands entered using the simple editor of the previous program. After executing program 5, the machine will obey each instruction within the text file as if it came directly from the keyboard, following each command until the end of file character (&5F) is read.

Figure 4 shows a typical command file entered using the editor and figure 5 follows the machine's activity while executing the file.

Program 5 begins by altering the ReaD CHaracter Vectors (RDCHV) to point to the new input routine 'IN'. After returning to Basic the machine operating system is directed to 'IN' instead of the keyboard to obtain commands. Subroutine 'IN' begins by saving the X register in location &82. Indirect addressing is then used to obtain a character from the command file which is passed to the operating system. When the end of file character is read, the contents of the input vectors are returned to their original values and the keyboard re-enabled.

```
>LIST
   10 REM PROGRAM PROVIDES A SIMPLE EDITOR
   20 REM TO STORE TEXT FROM &2000 UP.
   30 REM KEY1..ENTER TEXT FILE
   40 *KEY1"CALL&0D50|M"
   50 OSRDCH=&FFE0
   60 OSASCI=&FFE3
   70 POINT=&80:REM ZERO PAGE POINTERS
   80 FOR PASS =0 TO 3 STEP 3
   90 P%=&0D50
  100[OPT PASS
  110.start LDX #0:STX POINT \ SET X=0 AND POINT
  120         LDA #&20:STA POINT+1 \ TO &2000
  130         LDA #ASC("+"):JSR OSASCI \ PLACE "+" ON SCREEN
  140.again  JSR OSRDCH     \ GET KEY
  150         JSR OSASCI     \ ONTO SCREEN
  160         STA (POINT,X) \ STORE IN TEXT FILE
  170         CMP #&5F       \ IS IT END "_"?
  180         BEQ fini
  190         INC POINT      \ UPDATE POINTERS
  200         BNE again      \ BACK FOR MORE
  210         INC POINT+1
  220         JMP again      \ BACK FOR MORE
  230.fini   RTS            \ BACK TO BASIC
  240]
  250 NEXT PASS
  260 END
```

Program 3. 'Editor' program to generate text file (use mode 7 on model A to avoid corruption by screen)

```
>LIST
   10 REM DISPLAY TEXT ROUTINE
   20 MODE7:N=&2000
   30 REPEAT
   40 A%=?N:CALL &FFE3
   50 N=N+1
   60 UNTIL A%=ASC("_")
```

Program 4. Basic listing to display text file

Program 5. 'Execute' program enables text file to act as command file

```
   10 REM PROGRAM TO EXECUTE TEXT COMMAND FILE
   20 REM KEY2..EXECUTE TEXT FILE
   30 *KEY2"CALL&0D01|M"
   40 POINT=&80:REM ZERO PAGE POINTERS
   50 XSTORE=POINT+2:REM STORE FOR "X"
   60 RDCHV=&0210:REM READ CHARACTER VECTOR
   70 FOR PASS=0 TO 3 STEP 3
   80 P%=&0D01
   90[OPT PASS
  100.START LDA #IN MOD 256:STA RDCHV \POINT VECTORS
  110       LDA #IN DIV 256:STA RDCHV+1 \TO NEW INPUT ROUTINE "IN"
  120       LDA #0:STA POINT \ SET UP POINTERS
  130       LDA #&20:STA POINT+1 \ TO "&2000"
  140       RTS      \BACK TO BASIC
  150.IN    STX XSTORE \STORE X
  160       LDX #0     \SET X=0
  170       LDA (POINT,X) \GET BYTE FROM FILE
  180       CMP #&5F   \END OF FILE CHARACTER?
  190       BEQ FINI  \THATS THE LOT
  200       PHA        \STORE ON STACK
  210       INC POINT \UPDATE POINTERS
  220       BNE HERE
  230       INC POINT+1
  240.HERE  PLA        \RECLAIM "A"
  250       LDX XSTORE \RECLAIM "X"
  260       CLC        \DECLARE VALID CHARACTER
  270       RTS        \INTO THE OPERATING SYSTEM
  280.FINI  LDA #&B9:STA RDCHV \BACK TO NORMAL INPUT
  290       LDA #&DE:STA RDCHV+1
  300       LDX XSTORE \RECLAIM "X"
  310       JMP (RDCHV) \BACK TO KEYBOARD
  320]
  330 NEXT PASS
  340 END
```

```
+NEW
PRINT"NOTHING THERE"
PRINT"I WILL NOW ENTER A PROGRAM"
10 MODE7
20 PRINT"FRED"
30 END
PRINT"I WILL NOW RUN PROGRAM"
RUN
LIST
PRINT"THATS THE LOT"
NEW
LIST
_>
```

Figure 4. Example command file

```
>NEW
>PRINT"NOTHING THERE"
NOTHING THERE
>PRINT"I WILL NOW ENTER A PROGRAM"
I WILL NOW ENTER A PROGRAM
>10 MODE7
>20 PRINT"FRED"
>30 END
>PRINT"I WILL NOW RUN PROGRAM"
I WILL NOW RUN PROGRAM
>RUN
FRED
>LIST
   10 MODE7
   20 PRINT"FRED"
   30 END
>PRINT"THATS THE LOT"
THATS THE LOT
>NEW
>LIST
```

Figure 5. Machine activity while executing command file in figure 4

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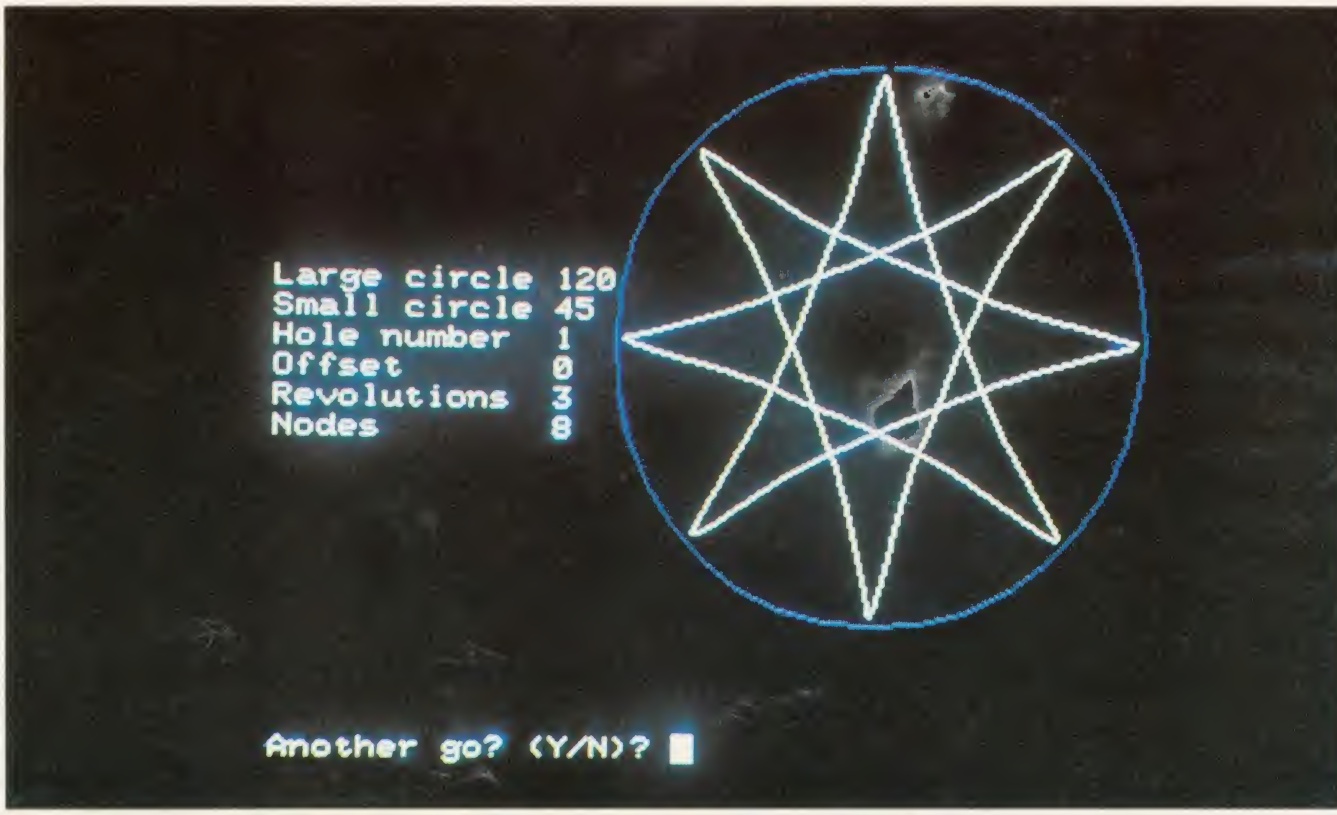


Photos: Malcolm Aird

Primary maths and micros

Ruth Townsend and Paul McGee advise on the choice, and use of, software for teaching mathematics to primary pupils. Good programs are the only way to develop the potential of the micro – but some topics are best left to other tools, such as Bigtrack or Simon.

We list some good sources of software and advice on page 48, while three educational programs are reviewed on page 51.

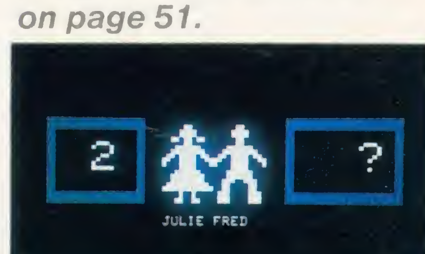
In January's *Acorn User*, Heather Govier wrote of using micros to enrich and extend the primary school curriculum. Teachers with an interest in maths will also want to examine the micro's role in relation to the *Cockcroft Report*, and in particular to paragraph 243 which issues the following challenge. Maths teaching, it states, should provide opportunity for:

- exposition by the teacher;
- discussion between teacher and pupils and between pupils themselves;
- appropriate practical work;
- consolidation and practice of fundamental skills and routines;
- problem-solving, including the application of maths to everyday situations;
- investigational work.

Most people in maths education today would agree that the first and fourth activities predominate in junior and secondary schools, although less so in infant schools where practical work is much more common. If the micro is to do more than merely enliven work, we must hunt down or create software that will promote other activities on the list. The relative scarcity of the micro as a resource makes the need for good software imperative. Drill programs have to be used individually and it is unlikely there will be enough machines in a primary school to make this feasible.

There is no doubt drill on the micro is more popular than drill from many current textbooks; and informal research shows children can complete up to four times as much work using the micro as they can with pencil and paper. This gives more time for the other activities advocated by Cockcroft, but the general theme of both the *Cockcroft Report* and *Mathematics 5–11* is that such skills could be better developed, with better pacing of pupils and faster recall of basic facts, if more work were done orally.

Many activities, such as testing tables or performing routine calculations, are catered for by such toys as *Little Professor* or

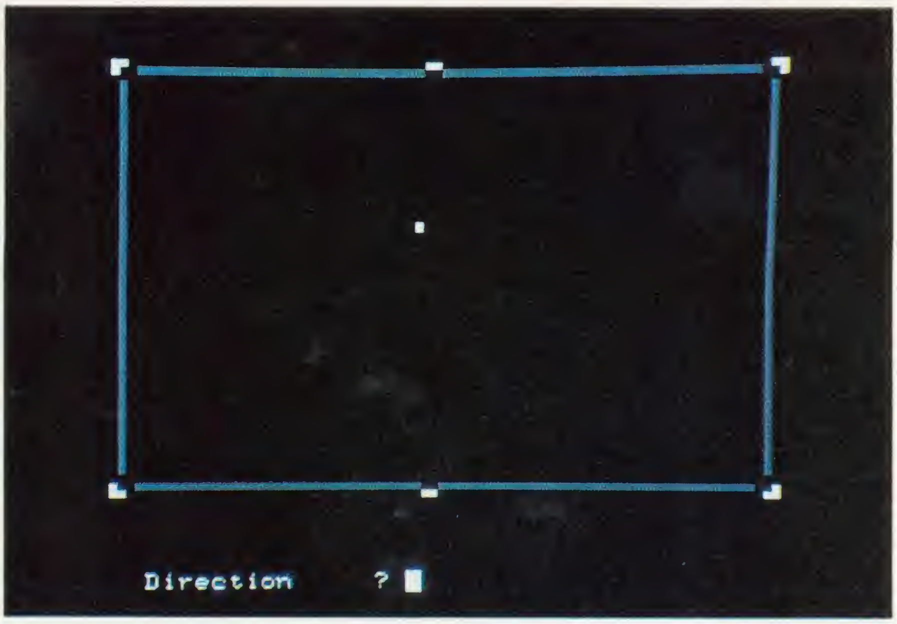


Dataman. These are much cheaper than a computer and can be purchased in sufficient quantity to allow a large number of pupils to use them at the same time. Both can be programmed to give various activities at different levels of difficulty. They provide valuable protection against practising errors and give the instant feedback pupils enjoy from a computer. If the school is following Cockcroft's advice and developing work with calculators then simple consolidation exercises can be made enjoyable and instructive at no extra cost.

There are many programs which aim to help pupils with their maths by helping them to develop a longer attention span and the ability to concentrate on details. These activities can easily and more cheaply be carried out using a simple game called *Simon* which asks children to repeat lengthening series of sounds related to flashing lights. *Simon* obviously lacks the flexibility of a computer program but do many primary school teachers spend much time altering programs to suit their specific needs? Instead of rewriting textbooks, teachers choose the material which best meets their requirements and budgets, and they should do the same for work with computers in maths.

However, the classroom management problem remains and opportunities for enrichment are wasted if the micro is overused for drill and practice. (Those outside education produce a multitude of simple arithmetic drill programs, which can generally run on the cheaper home computers, and teachers who have ZX81s or the like may find a use for them in these areas.)

Of those programs which work on the micro supported by the DoI scheme, *Trains* (from NECOPS) is fun. Its title frame calls this 'arithmetic training' and that is all it is, but it has the features demanded of a drill program: rewards for success, a timing feature and flexibility of levels. It can neither teach nor diagnose – reassuring to those who make their money by these skills!



Small groups and discussion

Good programs for small groups rather than individuals aim to promote discussion between pupils. Nothing does this better than a game which practises and applies a skill. Two favourites for the primary school both come from SMILE.

The first is *Elephant* where the task is to locate an elephant hiding in a grid of New York streets. After each guess the micro tells the users their distance from the elephant. Pupils develop strategies and discuss the relative merits of proposed guesses. Achieving problem-solving and discussion with one simple program must enrich the mathematical diet.

***Snooker* should carry a warning about potential addiction. The object is to pot a ball in one of the pockets by stating the angle of the course in which the ball is to move. The pupil is thus applying skills of estimating angles.**

Top, Snooker; above Boat

For group work, *Ergo* and *Subgame*, from the Shell Centre, again promote discussion. In *Ergo* the micro generates a five-by-five grid of whole numbers following a rule. The user's task is to fill in any of the numbers by moving the cursor. Incorrect inputs are given the response 'too high' or 'too low'. There are two levels of difficulty, the harder would probably be beyond most juniors, but it is a robust program which practises the skills of number pattern work.

***Subgame* does nothing that could not be done with marked cards and an outline subtraction sum, but has proved successful in the classroom. Both the user and the micro have to place randomly produced digits into a subtraction sum so as to maximise the answer. To play it successfully needs a strong sense of place value and subtraction. There is a restrictive algorithm which gives the user the answer at a fixed stage but it is still worth using.**

The most discussed mathematical programs at present rate are *Jane* and *Logo*, both of which will be used most profitably in small groups. *Jane* is available, with extensive notes, from Longmans

Micro Software. It is the 'function game' used for years in progressive maths lessons based on the format of input/operation/ output. Functions are given boys' and girls' names, where the default conditions are that boys add and girls multiply, although the precise operations can be set differently. It has potential which a brief review cannot do justice to, and is well worth viewing at your local teachers' centre.

The same is true of any version of *Logo* whose application goes beyond maths. The way it helps to develop the concept of angle measure, the nature of a program and variables, and a structured approach to problem-solving make it a must for maths lessons. The most easily available version, suitable for all the DoI approved machines, comes in the *Logo Challenge* package from Addison-Wesley. It's beneficial to use *Bigtrak* before using *Logo* and a recent MEP publication is helpful.

Problems and investigations

The MEP *Micro-primer* pack contains two mathematical programs which at first glance seem to demonstrate the micro's capacity to stimulate practical work and investigations.

First there is *Shopping* which takes pupils (or significantly, one pupil!) on a shopping trip. There are representations of a shopping list and some coins, and it is hard to see how this activity is better than handling either real money or plastic money. This is typical of programs which are written to satisfy some craving which the programmer had, presumably the desire to prove that coins could be drawn on the screen. No doubt there will soon be programs which simulate structural apparatus, measuring equipment, attribute blocks and the like. The optimist will see this as motivating practical work away from the micro, but pessimists will fear that equipment will return to the dust of the stock cupboard.

The other MEP mathematical offering is *Farmer* where the user is invited to solve the farmer/dog/children/grain crossing-the-river problem. It makes good use of the micro because pupils are invited to participate, but is not nearly as rich in potential as the similar *Boat* (from SMILE). This program is also about crossing rivers but leads to a worthwhile investigation.

A good investigational program for small groups must generate plenty of work away from the micro and exploit its ability to support conjectural work in maths. There are few such programs available at primary level as yet, but other examples are *Frogs* (from SMILE) and *Jugs* (from Davidson Centre, Croydon).

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Setting up lessons for the whole class

It is likely that many teachers will want to use the micro for lessons with the whole class. If this is not to be in the style of poor pre-micro class lessons, software should satisfy some or all of the following criteria:

- stimulate class discussion;
- reach all pupils, irrespective of ability;
- engage the class in 'what if?' activity;
- lead to plenty of work away from the micro.

Takehalf (from SMILE) is one such program. It runs for about 12 minutes and operates in film-mode, ie the only interaction possible causes the program to pause or continue. A square is disected in a host of ways so that black and white areas are always the same.

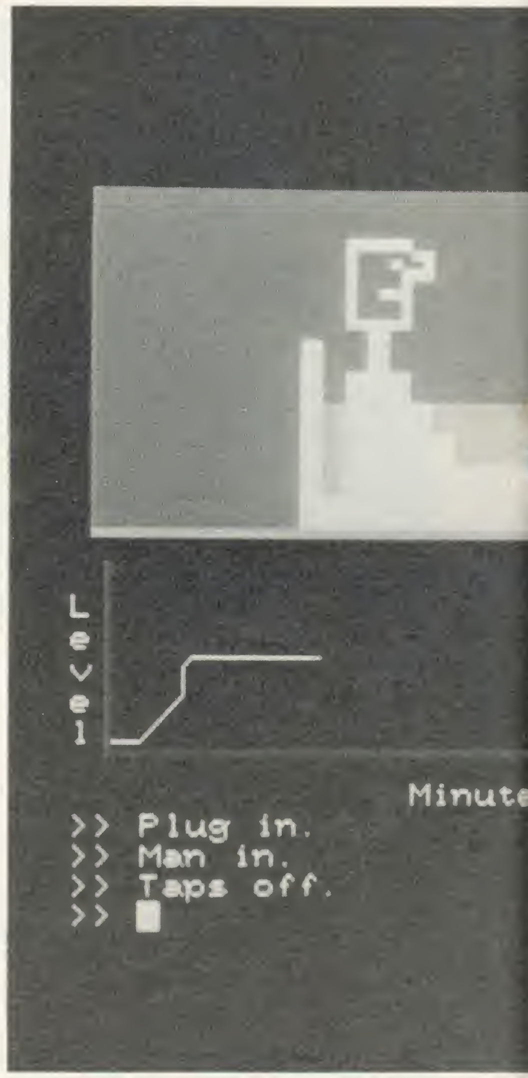
Whether it is shown as an initial stimulus or after the same activity has been done with paper and scissors is a matter of judgement. The author, Ronnie Goldstein, gives an interesting account of work based on the program in *Some lessons in mathematics using a microcomputer* shortly to be published by the Association of Teachers of Mathematics (ATM). One look at the program will impress the primary teacher with the wealth of potential for language work in maths.

A second strong program for class use is *Spiro* (Davidson Centre, Croydon) which is designed to follow up practical work with a real Spirograph. It has been used to investigate the connection between the number of teeth on the cogs being used, the position of the pen within the cogs, and the nodes and revolutions of the resulting pattern. Pupils initially use the micro to check it is a good model of *Spirograph*, ie the patterns made by the micro match those made by the pupil using the plastic wheels. When this has been established, the pupil can use the program to test hypotheses which would be too tedious or impossible to test with the apparatus. The strength of this approach is that when pupils think they have a theory it can be tested speedily. This is the essence of satisfying conjectural work.

Pupils are also encouraged to design new spirographs which can create patterns which are impossible with the material version. *Spiro* has also been used to develop spatial awareness and a broader range of problem-solving skills in pupils who are poor in these areas although good at numerical work. The program is now being developed more fully as part of an MEP–funded project on developing thinking skills in the primary school, but early unsophisticated versions are available from the Davidson Centre, together with some notes prepared for pupils on a primary gifted children course.

Eureka also allows the immediate testing of hypotheses. Again from Shell Centre, this shows, in both graphical and pictorial form, the water level in a bath as taps are turned on and off and plugs are put in and pulled out. The teacher can opt to show only one representation so there can be discussion about what must have happened to produce a particular graph.

'One look at the program will impress primary teachers with the wealth of potential language work in maths'



Addresses

SMILE, Middle Row School, Kensal Road, London W10

Shell Centre for Mathematical Education, University of Nottingham School of Education, University Park, Nottingham NG7 2RD.

Addison Wesley Publishing, 53 Bedford Square, London WC1B 3DZ

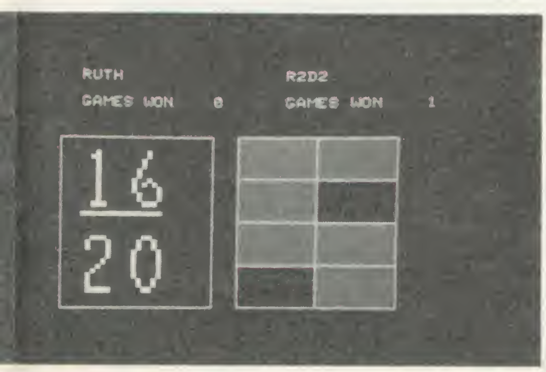
Ruth Townsend, Maths Advisory Service, Davidson Centre, Davidson Road, Croydon CR0 6DD. Tel: 01-656 0913.

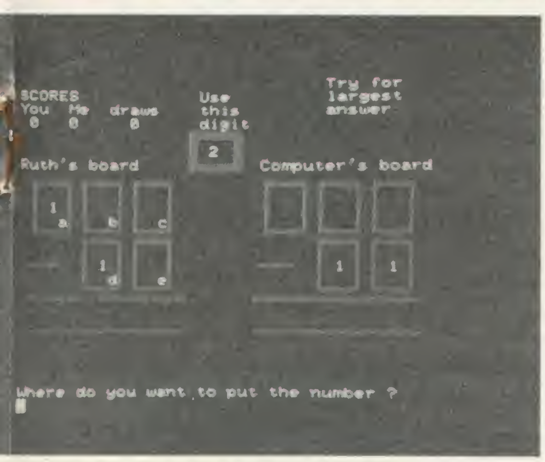
Longmans Micro Software, 33-35 Tanner Row, York, YO1 1JP.

NECOPS, Newman College, Genners Lane, Bartley Green, Birmingham 32.

ATM, King's Chambers, Queen Street, Derby DE1 3DA

Bigtrak plus, MEP Case Study 3. Contact nearest Regional Information Centre for details.





Practical considerations

There is great potential in maths teaching, particularly in work involving drawing or movement, to use the micro as an electronic blackboard. If a micro is used in this way for class display the screen must be clearly visible to all pupils and it is unlikely that the monitors supplied with the DoI package will be large enough. One possible approach is to use the school's colour television, but the difference in quality between an RGB monitor and a domestic television is quite startling. It may be worth enquiring whether your LEA has arrangements for converting ordinary colour televisions to RGB for computer use.

Some schools may still have black and white video monitors which are useful for programs such as *Jane, Jugs or Subgame* but many others loose much of their impact without colour. It is also frustrating for a pupil to be asked to choose between, say, a red dot and a green dot when they both appear grey. Graphics which have been created using subtle blends of colour often virtually disappear on black and white screens and blue lines often appear very faint.

Programs which use lengths or angles can become confusing if a horizontal unit of length does not equal a vertical unit. This may be caused by a badly aligned television (easily cured by a technician) or by faults in the software which have to be cured by incorporating scale factors into the drawing routines. The problem is compounded if the printer, which might be used to copy the diagram from the screen to paper, uses different proportions to those on the screen. Most printers can be set from within the program to give a variety of horizontal or vertical spacings, but teachers need to be prepared to answer pupils who measure lengths or angles and discover that the computer is wrong.

One neglected use of the computer is computer managed learning (CML). This could be valuable in a subject like mathematics where the order of acquiring skills is important. It entails diagnostic testing for those having difficulties, and good record keeping. There are programs designed to free the teacher from these clerical tasks so more time can be devoted to curing the problems. All such systems need some means of accessing data quickly, such as floppy discs or cartridge disc microdrives, and using cassette storage is not sensible.

Build on the work scheme

Mathematics in the primary school must be carefully planned and co-ordinated if pupils are to have a satisfactory range of experiences, develop the necessary skills a positive attitude to mathematics as an interesting and enjoyable activity. Most schools have a scheme of work (often based on a major scheme such as Nuffield, Scottish or Fletcher) and a teacher with responsibility for mathematical development. It is crucial that careful planning precedes the use of micros in the teaching of mathematics to ensure consistency with the scheme used. A school using the Scottish mathematics scheme, which strongly favours decomposition for subtraction, would have to consider carefully using a program which depended upon equal additions.

The integration of the micros into the teaching of maths means teachers cannot opt out of using the micro once it has been decided by the school that it is the only sensible way of developing particular skills. This places pressure on the single micro in a school, particularly when it will be used for other activities, and highlights the points made in Charles Bake's article about where the computer is sited (February *Acorn User*).

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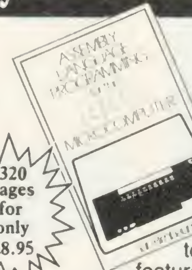

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Assembly Language Programming for the BBC Microcomputer
Ian Birnbaum

The Acorn/BBC Microcomputer is arguably one of the most advanced computers in the low to medium price range. It certainly has features that other machines lack. For example, both the model A and model B machines are equipped with a powerful assembler program that can assemble machine language statements. Mixing assembly language statements and BASIC statements enables the programmer to increase greatly the capabilities of the computer by writing fast subroutines for games, graphic simulations, etc.

Contents include:
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Indirect indexed addressing
Multiplication and division
The stack – Subroutines and interrupts
Some useful utility programs

Exercises are included throughout and there are several valuable appendices.
Save time and effort with the double cassette pack containing all the programs in the book.

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Three useful educational programs

MAZE is a program which sets up mazes and displays them in plan view. Pupils are required to navigate a cursor around the maze from a given starting point to home by typing the instructions 'left', 'right', 'up' or 'down' at each intersection. Each run of the program sets up a different maze, although the starting point is always the same.

The game was played with the whole class volunteering instructions. Three pupils sat in front of the computer, with a screen to separate them from the class, and were shown how to use the return key. They had a card to remind them of the instruction keys and how to obtain a new maze.

After about ten minutes, two pupils left the computer, and two others replaced them on the keyboard, leaving one to instruct the newcomers. In this way, every pupil had a turn at the game, and they needed very little teacher help.

This program is useful as an introduction to the computer –every child achieved success, and their concepts of 'left', 'right', 'up' and 'down' were greatly improved.

Pupils showed great co-operation and teamwork in deciding on an instruction and learnt quickly from each other.

Tower and *Snap* are not names one would readily associate with the teaching of fractions. However, both are examples of the type of computer programs which offer the teacher avenues of practice normally only possible through lengthy, conventional, mechanical methods, at which pupils of low ability or short attention span often fail.

The programs arrived as part of a package delivered for use with our first school computer. They were used in the context of the school's normal schemes of work and supplemented conventional teaching methods. The computer was thus being used as a tool rather than as a teaching machine.

Tower was presented to show visually the size and notation of fractions by building a progressively larger tower of colour. This may be possible with other equipment but the program offers a clear, simple, efficient method of demonstrating the principle. It supplements the teacher when used individually or by small groups.

Pupil ability ranged from remedial to gifted, but all achieved a high measure of success. The groups were balanced and discussion before each new fraction was entered led to a good deal of oral language work.

There was a satisfying degree of enjoyment present in using this program, reinforcing the process being developed. Although the points and processes could have been achieved without a computer, in terms of productive use of curriculum time results clearly justified the use of such a resource.

Tower was used in conjunction with *Snap*, where equivalent fractions appear on the screen as shaded portions of cards. The idea is that when a pair of equivalent fractions appear the child touches the keyboard space-bar to signal 'snap'. A sensible amount of time is allowed as the fractions change to allow the pupil to think.

Listening and observing individuals at the keyboard, and later during more concentrated questioning, showed everyone had quickly achieved a high level of proficiency in recognising equivalent fractions.

Maze: Origin unknown but many maze programs are available.
Tower: Available from SMILE, Middle Row School, Kensal Road, London W10
Snap: Available from Newman College, Genners Lane, Bartley Green, Birmingham 32. (This will be in *Microprimer pack 3.*)

Tony Pierce
Barabara Tarranto
South Norwood Primary School, London

Ten points to note

- **Plan the use of each program for individual, group or class use. Some programs can be used in more than one way.**
- **Use the appropriate equipment for particular programs, eg colour monitor, printer or discs, and consider the effect on the pupil of their absence.**
- **Remember Cockcroft's advice about mental and oral work; using computers is a poor substitute for either.**
- **Exploit the computer's power to motivate, particularly through graphics, but do not trivialise maths or insult your pupils' intelligence.**
- **Work through programs yourself before using them with pupils, just as you would with any other new material.**
- **Integrate the use of the micro into normal maths activities while exploiting its capabilities.**
- **Do not restrict the use of micros in maths teaching to the least or most able. Make them available to all pupils.**
- **Do not use computers to replace practical work which is essential for concept formation.**
- **Consider whether programs should use standard units for lengths, particularly as it is possible to copy diagrams on the screen onto a printer which alters the screen proportions.**
- **Do not use expensive computers to perform activities which could be done equally well on small devices like *Little Professor, Dataman, Simon* or *Bigtrak*.**

Next month: teaching programming to primary pupils

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LOGO CHALLENGE

Heather Govier and Malcolm Neave
Project Adviser: Paul McGee

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- Features the "turtle graphics" of the LOGO language
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- All drawings can be stored for later re-use or incorporation into more complex patterns
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- Side two contains the Answer File TEACH, which gives solutions to all the Pupil Book Challenges

Availability

LOGO CHALLENGE is available in four different Teaching Packs, one for each machine. Each Teaching Pack contains one copy of the Pupil Book, one copy of the Teacher's Guide, and two copies of the appropriate cassette or disc, one of which is a back-up copy. The Pupil Book is also available separately in packs of five.

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Microprimer – neat package but short on software

by Heather Govier

Every micro supplied to a primary school through the Department of Industry scheme will arrive accompanied by a distance learning package called *Micro primer* produced by the Microelectronics Education Programme.

The *Micro primer* consists of a number of distinct elements; text, audio cassettes and computer software. It is envisaged that the package will provide about 30 hours of study for teachers either working alone or preferably with colleagues. This individual study should be followed by two day courses to be run by LEAs. Indeed, it is a requirement of the DoI scheme that schools receiving the half price subsidy undertake to send two teachers for such training. So LEA courses cover similar ground. a 'tutor guide' is in preparation.

The *Micro Primer* consists of: a wallet containing an *Overview, Study Text, Reader,* audio case-studies and regional information leaflet; an *Easel* containing the *System Guide* and an *Activity Guide*; two software packs – *Microprimer Pack 1* and *Factfile*.

Unlike the materials in the wallet, the easel and the software are machine specific.

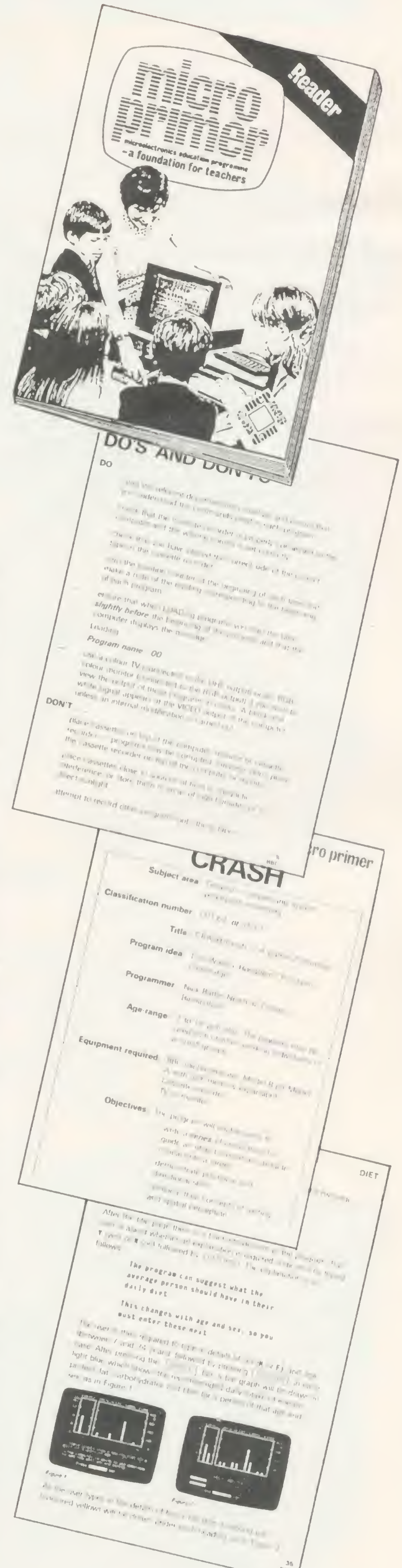
The *Overview* is intended to guide the student through the pack, structuring the material into a coherent course, which should be read before anything else. It contains a statement of the aims and objectives of the package which are to: introduce teachers to uses of micros in schools; give teachers confidence in using the micro throughout the curriculum; introduce some concepts of information technology; introduce social and education implications of technology.

There is little to quarrel with in this and the package meets the objectives drawn up well, although there is perhaps undue emphasis on social issues. Teachers will primarily be looking to the *Microprimer* for practical support in introducing the microcomputer into the school and classroom. Discussion of broader issues might have been better left to articles in journals and magazines. On the other hand, perhaps it is sound policy to punctuate a 30 hour curse with more thought-provoking items.

A figure of 30 hours is probably rather low for most novice teachers. There is a large practical component to the course, true study time may well be twice the quoted figure.

The suggested routeway through *Microprimer* has 22 work units which vary from text based to practical, many units having an element of both. The route is certainly a winding road, but makes an interesting and varied progression through the material. Symbols are used to indicate the type of activities involved in each unit, a format which is useful in planning a course of study.

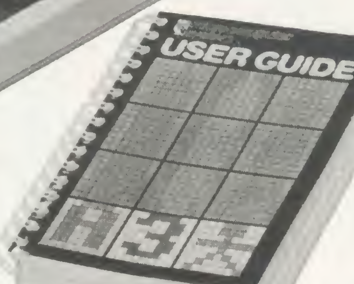
The *Study Text* was written in only eight weeks by David Chandler and forms an excellent



Cover of the software book, with some sample pages explaining programs

▶page 56

WORLD'S LARGEST LIST OF



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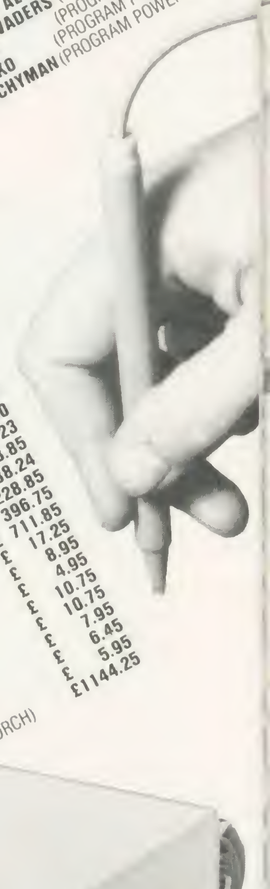

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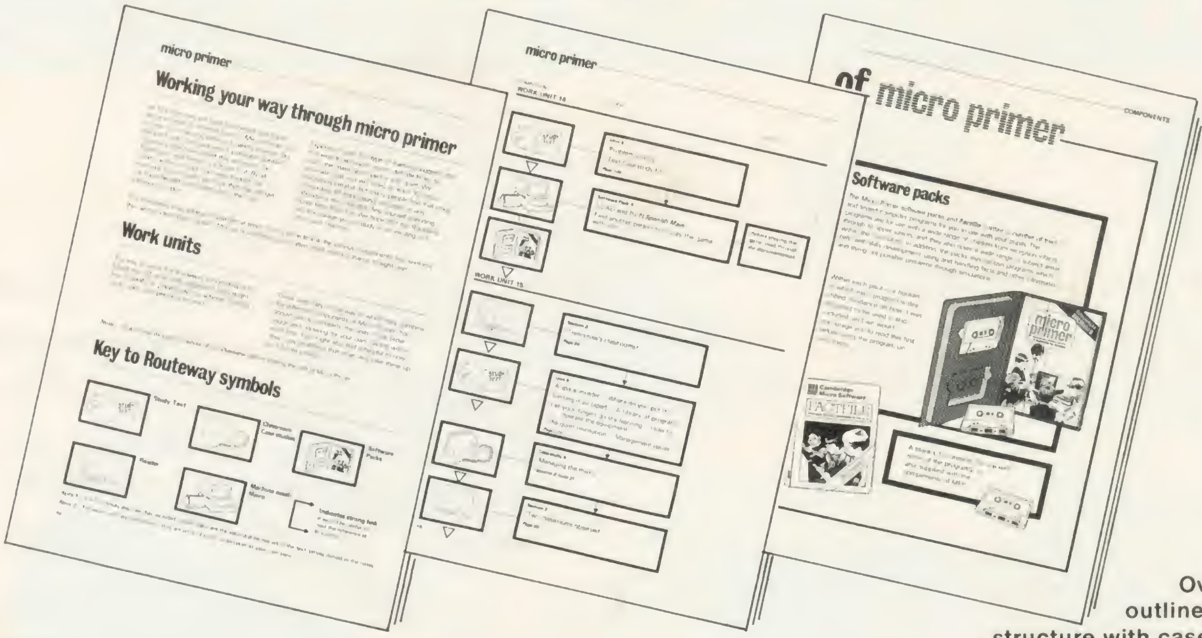


Overview – outlines course structure with case studies

▶ *page 53*

core to the package. The text aims to introduce the new technology in a straight-forward manner avoiding jargon and this it does admirably. A glossary explains most technical terms.

The book is divided into seven units, each concluded by review activities and references for further reading. It is well indexed and attractively presented. A number of articles referred to in the text have been grouped together by Derek Daines, and presented as the second component of the *Micro-primer – The Reader.* They have been chosen primarily for their capacity to provoke thought and discussion.

The largest part of the book is Section 2 – 'Computers in the Classroom', bracketted by shorter sections on social implications and implications for primary education. Most of the articles have been written by practising teachers and the approach is pragmatic. The writers describe computers in use in a way that has worked well in their schools. This transmission of first hand experience is an excellent way for teachers to learn about the educational possibilities of micro-computers.

Whilst some of the articles in *The Reader* have been specifically commissioned, many have been drawn from previous publications. They are linked by editorial comments and although very varied in style and quality make interesting reading.

Neatly stored in the flap of the *Microprimer* wallet are two audio cassette tapes which contain four 25-minute case studies. These allow primary teachers who are using micros in their classrooms to explain in their own words what they are using them for and why.

The *Case Studies* consider structured reinforcement data handling, simulations, *Logo* and management of the micro, with the debate over what constitutes a 'valid' educational use of micro-computers running throughout. While much of the content of these tapes is duplicated in other parts of the package, the use of this alternative medium adds variety to study of the *Microprimer*. The fact that they can be listened to by a number of people at once means they could be used as a focus for staffroom discussion and debate. It is difficult to see how the textual materials could be studied by more than one person at a time however and so group use is likely to be limited.

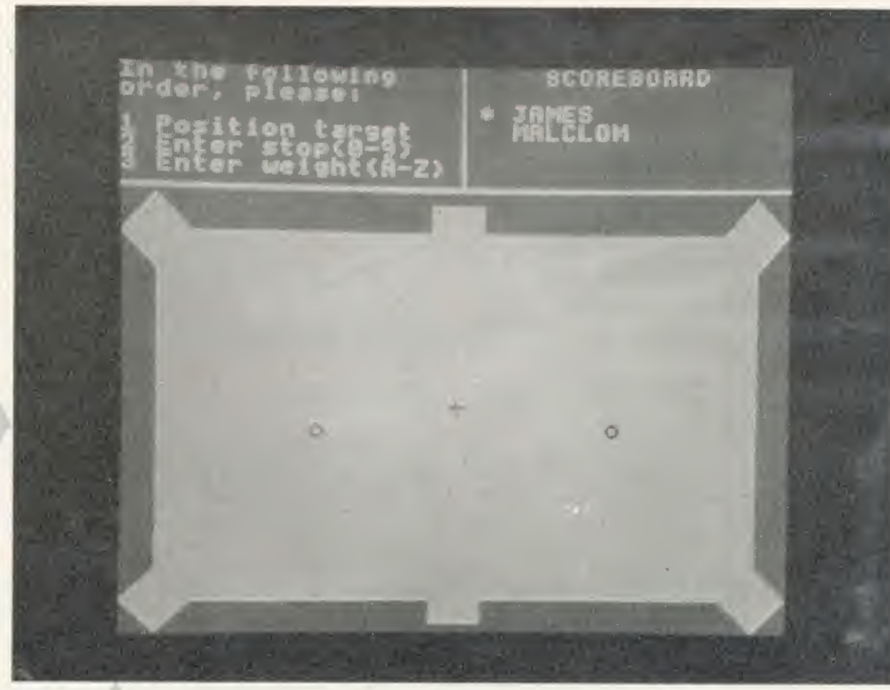
Following the format adapted in the *Input* package produced by MEP for the secondary sector, the practical guides in the *Microprimer* are presented in the form of a handy *Easel*. This can be stood next to the computer for easy use and contains a *System Guide* and an *Activity Guide,* both machine specific.

The *System Guide* is a series of instructions for setting up the micro and loading, running and saving programs. Good use is made of pictures and all keyboard characters to be typed are written in blue. The use of most of the specialist keys is described with examples and the meaning of screen prompts and error messages is explained. In practice, however, the *System Guide* lacks clarity and is ambiguous for novices to use without help. Occasional errors cause further confusion.

The *Activity Guide* on the reverse of the *Easel* is an insructional exercise designed to introduce teacher to programming. Although of less use to the average teacher, it is clearly presented and makes a good introduction to programming. In addition to writing programs, the guide covers the adaption of existing programs by changing data statements and print statements.

The remaining component of the *Microprimer* package is the software – perhaps the least satisfactory element. One cause for disappointment is the fact that only one of the four promised software packs is being supplied with the package, as much is not yet ready. Thus instead of receiving 30 software items with their machines, schools will get only 12. Of these, two are short programs designed to help in the setting up of the sysem, one is simply a datafile used by another program and the pair called *Mquiz* and *Quiz* are really two stages of the same activity, so there are really only eight discrete items of software. For schools in areas with good LEA software support this may not be too serious, but where such support is not forthcoming eight programs is shamefully few. A detailed review of these programs will be included in the next issue of *Acorn User*.

Five offerings for the BBC micro from two houses. . .



Billiards, H & H Software, Model B, £8.50

Chain this Model B game and you're looking down on a lime-green billiards table. Your ball is blue, your opponent's is green (you can't play the computer). Instead of a cue, there's a cross on the screen – blue when it's your turn, green when its your opponent's. You use the arrow keys to move your cue. But try to avoid moving the cross over the balls, they get rubbed out. Also the table is not quite flat – just to make the game more interesting! Backspin or 'stop' is keyed in using 0 to 9; speed or 'weight' is any letter a to z. If you manage to hit another ball, there's a satisfying 'crash'. The computer keeps the score for pockets, in-offs and cannons – just like the real thing.

Alan Pipes

Eldorado Gold, Program Power, Model B, £6.95

This is a whacky adventure-style game set in the Wild West. *Eldorado* though holds the interest with amusing comments (some mis-spelt!) and sound effects. It is mainly conversational, but with the odd little graphics window giving the setting. Commonly used commands: take, drop north, south, etc can be accessed via the user definable keys. When you're really stuck, a help button gives (sometimes) helpful hints. You can't save games, so you'll have to get adept at taking and dropping – a score is available though (by going back to the hotel!) at any time.

Alan Pipes

Disassembler by Program Power, £5.95

The popularity of machine-code programming is reflected by the fact that BBC machines have a built-in assembler, so it is not surprising that a disassembler is now available. Requiring only 4k to run, the program is suitable for both A and B models, and can be located at any position in RAM. When run, the program prompts for start and finish addresses and an address for assembler code to be placed. This last optional feature stores disassembled code in the given area of memory with labels for each instruction, and its format is such that it can be amended as required and then re-assembled. ASCII symbols can also be output, and the whole lot can be dumped to a printer.

This is a small, straightforward disassembler with none of the debugging features seen in more sophisticated (and larger) programs, such as breakpoints and memory moving. It does its job accurately and well, and will be a welcome and useful addition to the machine code programmer.

Philip Garritt

Tess, H & H Software, Model B, £8.50

No this isn't an Adventure game based on the novels of Thomas Hardy – it's a graphic design package for producing repeating patterns. You start with a white square which you can add to or cut away using fine or coarse 'pencils' controlled by the arrow keys. It's like sculpting in two dimensions. But watch out – every time you add something to the right-hand side of the square, the computer is eating away at the left. It's making sure the shape will tesselate. So get out your book of Escher prints and have a go! Two points though – it will only do straight repeats, not rotated or mirrored repeats, and an even coarser 'hammer and chisel' or area filler would be useful.

Alan Pipes

Reversi by Program Power, £4.95

Reversi is the Victorian predecessor of the popular *Othello* game. Play is between black and white only, with black going first. When a counter is placed, any of the opposition's counters trapped in a straight line between it and others of the same colour are reversed. Play proceeds in this way, with counters on individual squares changing colour many times in the course of a game, until the board is full of black and white counters and a final tally is taken.

The program offers the player choice of colour, and will not allow any illegal moves. The large eight by eight board is displayed on the screen along with the current score. Despite the fact that the computer only takes two or three seconds to make a move, it thrashed me every time.

Surprisingly for a game of this type only one level of play is allowed, and no instructions are included. I don't think this program would encourage me to take up the game more seriously.

Philip Garritt

. . . Three more offerings, some more disappointing than others

Painting, Drawing, BBC Soft, Model A, £10 each

These two programs, by the same author, have many similarities, therefore after a brief description of the facilities which each offers, I shall make general comments about both.

Painting is concerned with different ways of putting colour onto the screen in mode 5. By using the function keys you can get the following effects: clear the screen; select logical colour; change the palette; GCOL parameter – OR, XOR or normal; blocks of random dots; blocks of solid colour; blocks of cross-hatched colour; polygons of solid colour (many-sided being a circle); superimpose text; give up!

The program cassette also contains *Trees*. This is a ready-made painting program which draws modern art-type trees and produces 'music' at the same time. There is also a fully annotated version of the main program, presumably so that you can use the ideas for your own programs – a commendable idea.

Drawing produces various line-drawn effects in mode 5, again selected from the function keys: clear the screen; set actual colours of foreground and background; draw a line of specified thickness; draw a polygon; draw a sphere; draw a cone; draw a squared grid; draw a 'horizon', ie a series of parallel lines giving a feeling of depth to the picture; add text; give up!

This cassette also contains a demonstration remarkably similar to *Trees*, called *Sculpture*, and annotated versions of the programs.

If you were to buy these programs hoping to use them with primary school aged children, except perhaps the very oldest, I think you would be disappointed. In my view they would be difficult for anyone to use who is not already confident with micro-computers, as not enough has been done to make these programs user-friendly.

Cursor handling in both programs is cumbersome as it is invisible unless you are pressing a key. Also, if you are trying to position the cursor near the edge of the screen and go slightly too far, it does not fold over to the other side of the screen, but puts you back in the centre of the screen, to start again!

Also there seems to be a bug in *Painting* in that as often as not when you press a key, the cursor does not appear at all, although it usually appears if you try a second time.

Setting up the effects is also awkward. Most effects require two or three parameters to be typed in every time you use that effect. It does not even allow you to default to the last known parameters for a given effect.

If these programs had been produced by a back-room programmer and sold at £5 for the two, I don't think you would have any cause for complaint, but when they come out at £10 each under the name BBC which we tend to associate with quality educational products, then I must feel disappointed. I don't know whether these represent good 'art', but they certainly do not represent good programming.

Paul Beverley

Footer by Program Power, £6.95

Footer is a two-player football game for the model B. There is only one footballer per side, drawn as stickmen with proper running movements of their arms and legs as you shift them round the green and white screen. Each player has a group of five keys on his or her side of the keyboard – four for manoeuvring and one to kick.

The footballers can be made to run diagonally by holding down two keys at the same time, and things get a bit confusing when they come into close quarters, as they look identical.

The top of the screen displays the score and time (games last 300 seconds), and also a moving direction indicator whose position determines the angle of the ball when it is kicked.

It is quite easy to learn the knack of making accurate goal shots. When kicked, the ball curls in the air, rebounds off the sides and slows to a halt in a realistic way. There is an option which allows dribbling the ball, in which case the player in possession can be tackled.

I found this game great fun to play, and it will be even better if Program Power produce a version for joysticks. The only crowd invasion I had to worry about was the gang who were kicking me off the machine so that they could play!

Philip Garritt

Programs 1, Programs 2, by BBC Publications

On the whole *Programs 1* is a motley collection – some programs appear to have been added simply to fill up the tape.

The advertising suggests that the 'programs have been carefully designed to let you understand how they work.' This reviewer found understanding difficult! A few of them are interesting from the point of view of giving useful algorithms which could be used in other programs. In particular, the rotating cube of *Cube* and *Plotter* which drew three dimensional graphs.

The accompanying booklet suggests some ideas for midfying programs to explore other features of the micro, but it proved very difficult to implement these. The reason being that none of the programs is well documented nor listed in the accompanying booklet. It is very difficult to read and work on a screenful of incomplete listings!

Much of the same criticism can be levelled at *Programs 2* without the redeeming feature of a few useful programs. The only useful algorithm here is a spinning globe. *Lunar Lander*, while a good game in its own right, does not justify the cost of the tape and would be better included in a series of games programs.

It is difficult to see the value of these tapes. If they aim to instruct there is not enough support material – if they aim to entertain, there is not enough interaction.

C.M.

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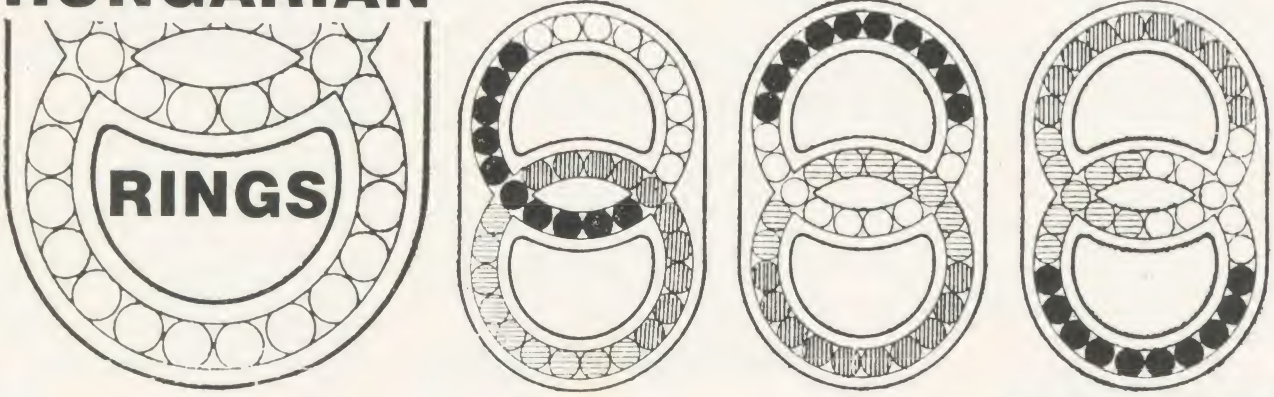

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Software critics

The **Bottisham Acorn User Group** first met last March and now holds regular sessions at the address below – although a new venue is being sought as Mr Harris's house becomes more overrun.

Each monthly meeting is devoted to a special topic. In December it was graphics, with members providing constructive criticism of each other's programs. January will be devoted to educational software.

The group is considering setting up a software library, and members are encouraged to bring along as much hardware as possible. For further details contact John Harris at 1 Rowan Close, Bottisham, Cambridge CB5 9BN. Tel: (0223) 811487.

Eastwood arrives

A letter has arrived at our office from **Eastwood Town Microcomputing Club** announcing their presence. They have two meetings a week and can be contacted through: Ted Ryan on Langley Mill 65011, Roger Hellings on Langley Mill 69281 or Robert Clifford on Ripley 812459. Their next fund raising event is in March.

Thanks from Sweden

There is now a **Swedish** Acorn user group (address below) and as you will gather from the name, it deals with both the Atom and the Beeb. They thank us for a 'very nice magazine' – we thank them for letting us know they are around.

Please use the latest list when trying to contact groups, as these are updated each issue. Most groups also appreciate a self addressed envelope for reply.

CLUB CONTACTS

● Rupert Steele
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● Mr B. Carroll
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● Mr P. Beverley
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● Steve White
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● Robin Bradbeer
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● Peter Smith
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● **Acorn Users Group of Sweden**
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● Ted Ryan
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EXCELLENT ON STRINGS

Bruce Smith gives his verdict on the Ross utility EPROM as a toolkit

The Ross Software utility EPROM plugs into the utility socket, IC24, and occupies 4k of memory from A000 hex onwards. Once installed, it adds a further 33 commands to the Atom's own Basic vocabulary. These appear as cassette OS commands and must therefore be prefixed with an asterisk. The toolkit provides a cassette interface, flashing cursor and a variety of aids to make life easier.

The Atom must be made aware of the utility EPROM's presence by executing LINK 44992 in direct mode, which should result in the normally inert Atom cursor beginning to blink on and off. The floating point ROM does not need to be present for the toolkit to work, and the entry address must be re-LINKed after BREAK.

Once initialised the Atom's 300 baud COS is replaced with a much faster, though less reliable, 1200 baud version. * TAPE controls the baud rate, being switched between 300, 600 and 1200 baud with either *TAPE1, *TAPE2 or *TAPE3 respectively. *BSAVE allows Basic programs to be saved so they may be *RUN in a similar manner to machine code programs.

*APPEND and *VERIFY are particularly useful. The former chain loads Basic programs onto the end of one another, whilst the latter command checks saved programs.

During all cassette input and output, visual indication of loading and saving is provided by a display of each byte transferred at the top of the screen.

The three most frequently used utility commands will undoubtedly be *AUTO, *RENUMBER and *DELETE. The first *AUTO provides automatic line numbering, the start and step values of which must be specified, such as *AUTO 10,10. A short bleep is emitted if the line number generated already exists. Similarly programs may be *RENUMBERED with GOTOs, GOSUBs and *RESTOREs altered to match their new destinations. Calculated jumps such as GOTO (20 + N) are ignored and must be located and altered separately. Blocks of lines may be removed using *DELETE.

*VAR prints the decimal values of Basic's integer variables, which may all be set to zero with *ZERO (useful for debugging). *PACK removes all those byte-eating spaces from programs, whilst preserving the so-called significant spaces. It does not remove REM statements, but these can be found and listed using *FIND.

The inclusion of *READ and *DATA gives the Atom a more standard Microsoft Basic feel and makes manipulation of numerical and string data a breeze compared with the somewhat cumbersome method outlined in *Atom Theory and Practice*. The data pointer is set to a specified line number with the use of *RESTORE.

*KEY $ N and *KEY N provide true keyboard scanning, passing any detected values to a specified string or variable, 'N', respectively. *WAIT provides programmable delays in increments of 1/60s.

Notes may be 'played' with *TONE D,P where 'D' is the duration of the note and 'P' it's pitch. *KBEP outputs PRINT $7 until a key is depressed.

*STOP has the same effect as LINK # FFE3 but prints the line number where the halt has occurred *POP allows subroutines to be 'jumped' out of without a RETURN – not good style.

Some good graphics facilities are included, the best of which are several excellent 'soft' VDU commands enabling strings of characters to be printed in any graphics mode. As an example, this program will print 'ATOM' in each mode at co-ordinates X,Y:

```
 5 X=4 ; Y= 28
10 FOR N = 0 TO 4
15 CLEAR N
20 *STRG X,Y "ATOM"
25 *WAIT 120
30 NEXT ; END
```

The current contents of the input buffer may be printed using *BSTRG whilst *CHAR will print a single ASCII character. *BLOCK fills an area of screen memory at co-ordinates X,Y and of size A,B. N defines whether the block is set, inverted or cleared, and is used thus: *BLOCK N X,Y,A,B

*POINT X,Y P tests the screen at position X,Y returning a '1' or a '0' in any variable 'P' if the point is set or clear.

The *SHAPE and *TABLE commands are difficult to understand, but once mastered allow any number of shapes to be defined and stored in a memory table. Plotting any one of the shapes is simple: *SHAPE 9, 20, 30 would draw shape 9 at screen co-ordinates 20,30.

The utility ROM arrived embedded in foil-covered polystyrene foam, protecting it from static electricity. The accompanying 12 page manual provides adequate information on the new commands, although the general layout is somewhat haphazard. Included is a useful section on the 12 new error codes used by the toolkit.

Only nine bytes of precious block zero RAM are accessed by the utility EPROM, namely AA hex to AF hex in zero page and 023D to 023F hex. However, *RENUMBER uses screen memory from 8200 hex as its scratchpad – not much good with a minimal Atom.

I have only two criticisms. First, utility commands such as *RENUMBER and *AUTO have no default values and if one or both parameters are omitted an error occurs. Second, the use of delimiting commas between variables after commands is not standard. Thus I found myself continually reaching for the manual to distinguish between, for example, *POINT X, Y P and *SHAPE N X , Y – minor points but annoying.

At £15.95, the Ross Software utility EPROM is good value and worthy of consideration. Details from: Ross Software, 44 Premier Avenue, Grays, Essex RM16 2SD.

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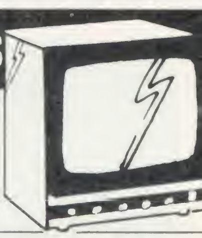

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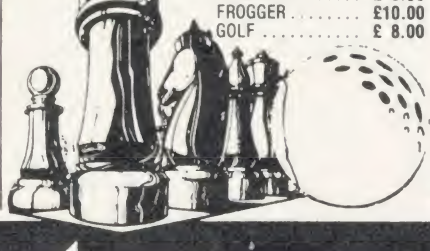

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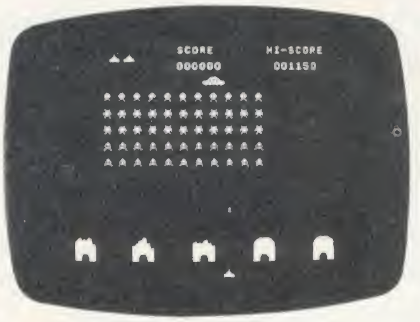

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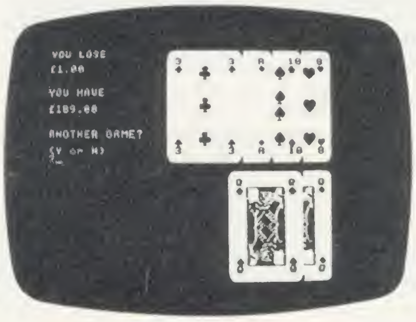

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Paul Beverley give the circuitry for a high resolution digital to analogue converter using a single output from the Atom

ANALOGUE CONVERTER

If you need a high resolution digital to analogue converter and are not too worried about how quickly it responds then you may be loathe to spend £30 for a commercial 12-bit digital to analogue coverter chip.

This article describes a versatile method of using an Atom to produce an analogue voltage. It has the added advantage over the conventional digital to analogue converter of using only a single output line from the computer. There is also a trade-off between the level of resolution and the speed of response which can be adjusted to suit any particular application. In addition, this method depends on generating a square wave with selectable time period and mark-space ratio – a useful facility for certain applications.

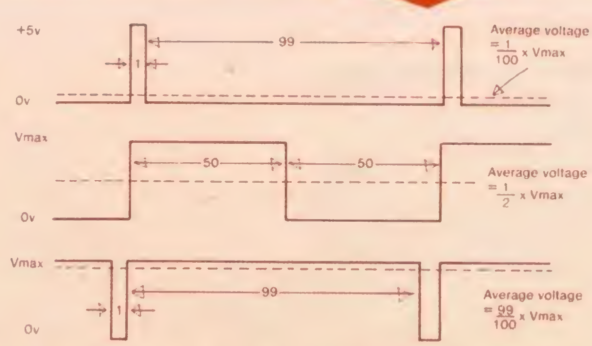


Figure 1. Variable mark-space ratio pulses producing different average voltages

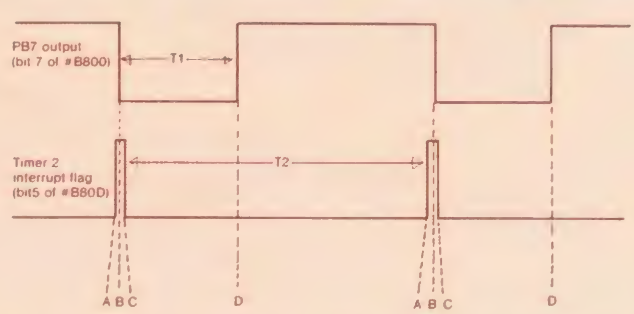


Figure 2. Timing diagram for versatile interface adaptor pulse generator. T1 is set by timer 1 and T2 is set by timer 2

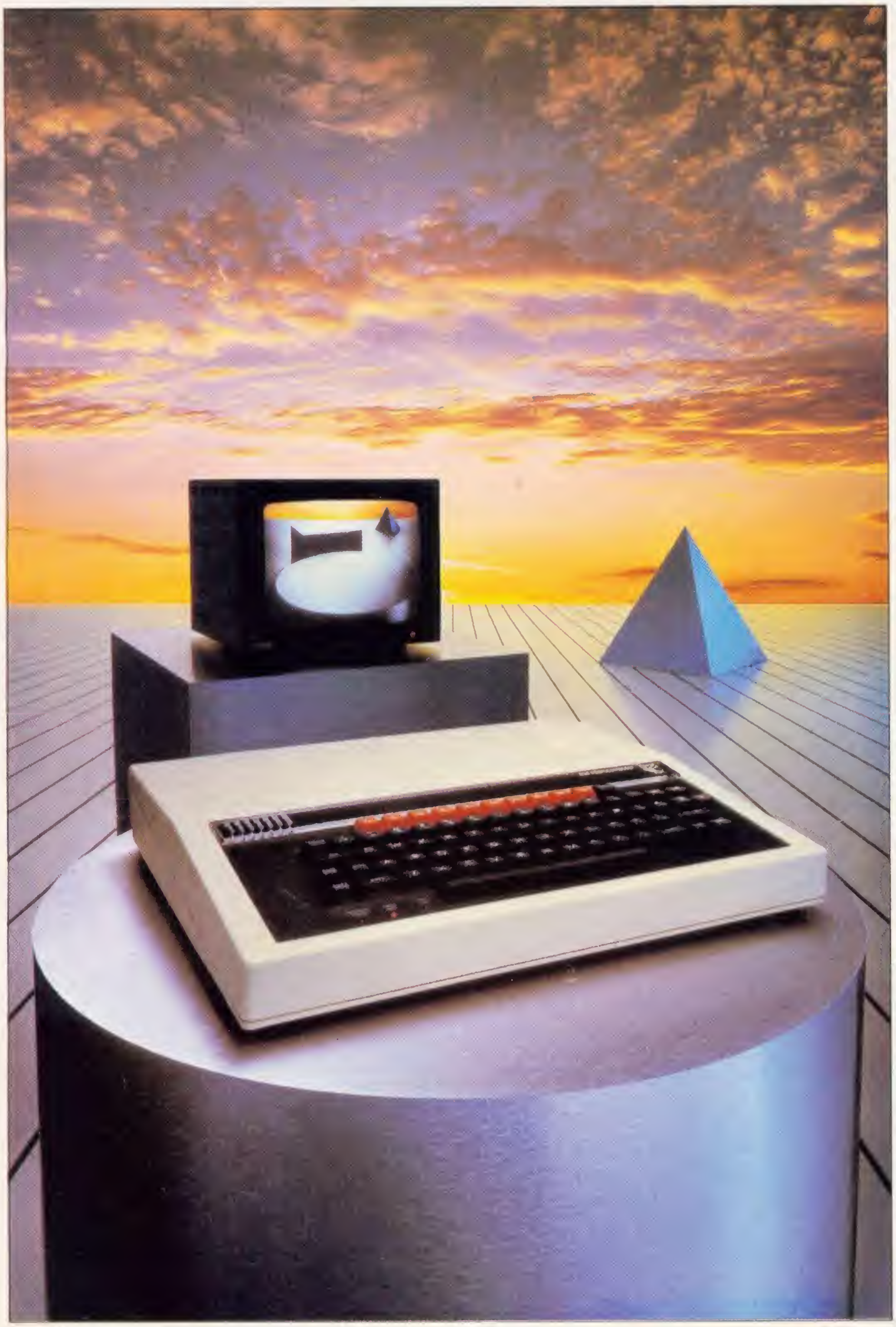
The idea is to use the two timers within the 6522 versatile interface adaptor (VIA), working under interrupt, to produce a square wave pulse of variable mark-space ratio. Figure 1 shows that as the mark-space ratio is increased, the average level of the signal increases. Therefore, if the square wave is put through an averaging circuit, we get a voltage output which is proportional to the ratio of 'mark' time to periodic time.

Because the timing of the pulses is done by the versatile interface adaptor, which runs at 1 MHz, we are limited to using timings in whole microseconds. Therefore, to get the same resolution as an eight-bit digital to analogue converter you have to set the periodic time of the pulses to 256 microseconds. For 10bits it would have to be 1024 microseconds, and for 12 bits, 4096 microseconds.

It takes a few cycles of the incoming pulse waveform for the averaging circuit to respond to changes in mark-space ratio. Thus for the equivalent of a 12-bit digital to analogue converter you need a filter with a response time of 10 or 20 milliseconds. This time depends on how much ripple you can tolerate in the output. The higher the resolution you try to get, the longer the periodic time has to be and the more critical the amount of ripple becomes. For example, one-bit variation in an eight-bit digital to analogue converter represents the equivalent of 0.4 per cent ripple, whereas one-bit variation in a 12-bit system is 0.025 per cent ripple.

Although it depends on the application, you may not necessarily have to keep the ripple down to the equivalent of a single-bit variation. It may be sufficient to be able to raise and lower the average voltage, with a resolution of one part in 4096, even though at a given setting the actual voltage may vary more than this, either side of the average. It depends entirely on the application as to whether you can get away with this.

The actual pulse is generated by the timers on the versatile interface adaptor. Timer one, which can be made to produce an output on PB7, is used to set the 'mark' time of the pulse. Timer two is used to give the overall time of the pulse. The timing sequence is shown in figure 2. At 'A', timer two has just timed out and generated an interrupt. The interrupt routine shown in figure 3 does the job of reloading and hence restarting both the timers. At 'B', the high byte of timer one is loaded, so PB7 goes



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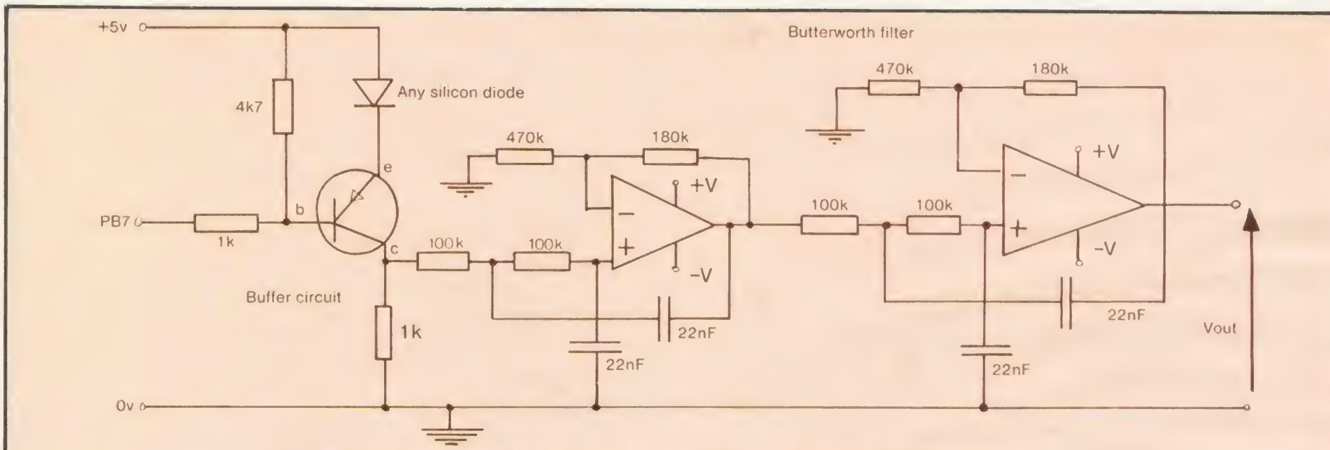

Figure 3. Buffer circuit and four-pole Butterworth filter

low. Then at 'C', timer two high byte is loaded which restarts the timing and clears the interrupt. When timer one times out ('D'), PB7 goes high again. When timer two times out again ('A'), another interrupt is generated and the whole process starts again.

The advantage of using interrupts is that the pulses will continue to be generated, once started, whatever else the processor is doing, unless the interrupt mask is set, in which case the pulses will stop until the mask is cleared again.

Program 1 is the interrupt routine plus the setting-up of the pulse generator with one particular timing.

Line 10:P is where the routine is to be assembled; I is the interrupt vector; B is the base address of the VIA; M is some free space in zero page for storing high-byte values for the timers.

Line 20 sets the interrupt vector to point to our interrupt routine.

Line 30. B?14 is the interrupt enable register of the VIA. It enables interrupts on the time out of timer two (bit five of the IER). B?11 is the auxilliary control register of the VIA. It sets up the two timers in the 'single shot' mode and enables BP7 to be an output for timer 1.

Line 40. This is the start of the actual routine. Get the high byte from zero page for timer 1.

Line 50. Get the high byte from zero page for timer 2.

Line 60. Restore the accumulator from the stack and return from the interrupt.

Line 70. This shows how to set the high and low bytes of the 'mark' time (in this case #800 = 2048).

Line 80. Set the value of the overall time of the pulse (in this case #1000 = 4096).

Line 90. To get the pulses started in the first place, you have to load the high byte of timer two using byte indirection so that when it times out, the interrupts start. After that the parameters of the pulse can be changed as in lines 70 and 80.

To stop the pulses, simply disable the interrupts by using B?14 = 32. To restart it again, use B?14 = 128 + 32 which re-enables the interrupts and B?9 = 0 to get timer two going again.

The circuit diagram in figure 3 gives a single transistor switch to invert the pulses from PB7 so the time set by timer one gives the on time rather than the off time. The bigger this value, the larger the output voltage will be. Because of the nature of the circuit there tends to be a problem with offset currents in the operational amplifiers. This means that a zero input does not produce zero output voltage and this cannot be adjusted by adding a normal offset zero adjustment potentiometer. This may not matter for a particular application, but if it does, replace the 741s with FET operation amplifiers such as 3140s which are pin compatible with the 741s.

The response time of the filter is set by the four 22nF capacitors. Using this particular value gives a response time in the region of 20 milliseconds which is what you

```
10 P=#3BF0;I=#204;B=#B800;M=#80
20 ?I=P%256;I?1=P/256
30 B?14=128+32;B?11=128
40 [LDA M;STA B+5
50 LDA M+1;STA B+9
60 PLA;RTI;]
70 ?M=#08;B?4=#00
80 M?1=#10;B?8=#00
90 B?9=0
100 END
```

Program 1.

would need for a 12-bit equivalent that gives approximately a one-bit ripple. If you want a faster response either because you are prepared to accept a larger amount of ripple or because you are using a lower resolution, reduce the value of these four capacitors accordingly.

The buffer needs a +5 volt supply which can come directly from the computer, but the operational amplifiers need a bipolar supply, ie a positive supply and a negative supply. However, since very little current is needed, you don't need to use expensive mains-powered supplies; a couple of nine volt dry cells will do. It would be a good idea, in that case, to put a 100 nF decoupling capacitor between each supply rail and the zero volts line on the circuit board, as near to the operational amplifiers as possible.

The other point to note is that the interrupt line on the 6522 VIA is not connected to the IRQ line on the computer. If you trace the track on the printed circuit board from pin 21 of the 6522, you should be able to find the link to join it up.

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Last month Barry Pickles reviewed Acornsoft's BBC Basic board for the Atom. Here, he gives some ideas on using it

HINTS ON USING THE BBC BOARD

As has been said, the BBC board manual is pretty abysmal and contains some errors. The pseudo-variable FALSE has a value of 0, not – 1. It also says you cannot use this board with the Atom DOS. In fact you can, but it's tricky! If you have a BBC Basic program starting at &0900, when you switch back to Atom mode that program will still be there, but it will now be at £2900. You won't be able to read it properly, but it's still there and you can save it as if it were an Atom program, using disc, or, if you have a toolbox ROM, on tape in fast COS.

Similarly, if you have a disassembler, you could use it on BBC programs or, indeed, on the BBC ROMs. To do the latter, you will need to copy the ROM into RAM, and program 1 is a simple block move to accomplish this. The program should be RUN in BBC mode and, on completion, it will give you the base address of the block, as it will appear in Atom mode. You then switch over, load your disassembler into a convenient block and away you go!

BBC Basic 'tokenises' all its keywords into two bytes. This has a number of consequences. First, you have no lower case letters. Second, abbreviating keywords is pointless since they will be printed out in full, when listing, and there is no saving. The final consequence is that, in Atom mode, a BBC program is unreadable, as it displays hordes of graphics characters!

The idea of having a standard graphics screen is a neat one, but it can cause unexpected slowness. What happens is that, if you plot a series of points from, lets say, 0,500 to 1280,500, the system will attempt to plot at every location inbetween. Of course, many of these points do not exist in reality, so a lot of time is spent waiting for the next plottable point to appear. If you want fast graphics plotting in loops, insert a suitable step size.

The Sound command does not work exactly like the BBC micro and the points that concern us here are the values for pitch and duration. The BBC uses values from 0 to 255 for each, whereas, in this implementation, values between 0 to 65535 are used, so, again,

Program 1.

```
10REM-BLOCK MOVE
20 INPUT"START ADDRESS OF BLOCK" A$:START%=EVAL(A$)
30 INPUT"END ADDRESS OF BLOCK" A$:FINISH%=EVAL(A$)
40 SIZE%=FINISH%-START%:DEST%=&1000
50 IF SIZE% >4096 PRINT"NOT ENOUGH SPACE":RUN
60 FOR LOOP%=START% TO FINISH%
70  ?DEST%=?LOOP%:DEST%=DEST%+1
80 NEXT
90 PRINT"MOVE COMPLETED - SWITCH TO ATOMBASIC"
100 PRINT"WHERE THE BLOCK BEGINS AT £3000"
```

Program 2.

```
10REM-DRAW TRIANGLES
20REM-DEMONSTRATION
30 MODE 0
40 FOR LOOP%=0 TO 10
50  PROCPLOT85(RND(1000),RND(1000),RND(800),RND(800),RND(600),
   RND(600))
60 NEXT:END
899REM-PLOT85
900 DEFPROCPLOT85(XMOVE%,YMOVE%,XDRAW%,YDRAW%,
   XAPEX%,YAPEX%)
910 MOVE XMOVE%,YMOVE%
920 DRAW XDRAW%,YDRAW%
930 DRAW XAPEX%,YAPEX%
940 DRAW XMOVE%,YMOVE%
950 ENDPROC
```

scaling will be required. Note that each single value is approximately one eighth of a note, on a musical scale. Further, the BBC micro has a buffer, which allows successive notes to be 'queued'. There is no buffer here and you must make sure that one note is completed before playing the next, otherwise the program will crash! To complicate matters further, the sound is 'interrupt driven', so the program will continue execution, even though the note has not finished. Setting the duration of the note to zero produces an 'endless' tone.

Many users will be aware that, on the Atom PCB, there are three unused address lines in the 'text RAM' area, and it is possible to piggyback extra RAM to fill memory from £2000 to £27FF and from £3C00 to £3FFF. If you have the latter, there is a possibility that any data sent, in BBC mode, to locations between &1C00 and &1FFF, will be corrupted. This is because Acorn really intended this area to use ICs 51 & 52 (normally block-zero on the Atom) but, with a piggyback, the system can end up trying to send data to both sets of RAM, with unforseen consequences! There is, however, a simple 'fix'. This is to remove IC12 (on the BBC board), **carefully** bend outwards pin six and replace the IC in its socket. Now, solder a wire from (the disconnected) pin 6 to any +5v line – there's one on the VIA. The effect is to completely disable ICs 51 & 52, when in BBC mode – of course, they work normally in Atom mode. This should only be done if you have RAM at £3C00. Any piggybacking for addresses below £2800 should be removed completely, since this is already provided on the BBC board.

Table 1. Operating system vectors

Location	Type	Vector
0200	Reserved	FFFF
0202	BRK	B42D
0204	IRQ	8000
0206	Reserved	----
0208	Command Line Interpreter	F775
020A	BYTE	F0D2
020C	WORD	F000
020E	Write Character	F54F
0210	Read "	FE6D
0212	Load/Save	F71A
0214	Reserved	----
0216	BGET	FBC1
0218	BPUT	FC51
021A	Reserved	----
021C	FIND	FC0B

All addresses are shown in Hex format.

Program 3.

```
10 REM-ALL STRINGS MUST BE DIMENSIONED
20 DIM A$(7), ALIEN$(7), BLANK$(7), ROW%(7)
29 REM-DEMONSTRATION
30 MODE 0:ALIEN$=" ":BLANK$=" "
40 PROCVDU23(ALIEN$,0,24,126,183,255,36,90,129)
50 PROCVDU23(BLANK$,0,0,0,0,0,0,0,0)
60 FOR C% = 1 TO 10
70 PROCPAT(ALIEN$,C%,4)
80 FOR N = 1 TO 1000:NEXT N
90 PROCPAT(BLANK$,C%,4)
100 NEXT C%:END
999 REM-DEFINE CHARACTER PLUS STORE IN STRING
1000 DEFPROCVDU23(A$, ROW%(0), ROW%(1), ROW%(2),
     ROW%(3), ROW%(4), ROW%(5), ROW%(6), ROW%(7))
1010 FOR LOOP%=0 TO 7
1020 A$ = A$ + CHR$ (ROW% (LOOP%))
1030 NEXT LOOP%
1040 ENDPROC
1998 REM-PUT CHARACTER ON SCREEN AT COLUMN X%, ROW Y%
1999 REM-32 COLS BY 24 ROWS IN MODES 0 TO 3
2000 DEFPROCPAT(A$,X%,Y%)
2010 Y%=(Y% - 1) * 256
2020 BYTE%=&4000 + X% + Y%
2030 FOR LOOP%=0 TO 7
2040 ?BYTE%=ASC(MID$(A$,LOOP%,1))
2050 BYTE%=BYTE%+32
2060 NEXT LOOP%
2070 ENDPROC
```

As for 'proper' memory expansion, Acorn have provided for an 8k expansion, from &2000 to &4000 in BBC mode. I assume (since I don't know anyone who has one), their own 8k card will work but, as for larger boards (eg Timedata, Audio Computers, Watford etc), these will only work by altering the addressing links, so that they begin at &2000. Note that only the first 8k will be addressed.

Finally, there are two areas of block-zero RAM available for the user. These are from &70 to &8F (32 bytes) and &021E to &02FF (225 bytes). All OS calls are indirected through vectors at &0200 to &021D. In this way, you can add your own routines, by altering these vectors to point to the address of your own routine. Table 1 gives the available OS vectors.

To round off, programs 2 and 3 provide two of the 'missing' functions – PLOT 85 and VDU 23 – so that you may implement published games programs. Program 2 is easy to follow, but you should remember that, in normal BBC programs, the co-ordinates represented by XMOVE% to YDRAW% have already been defined before the call to PLOT 85. These programs could be more elegantly written, but they will give an idea of how to overcome some of the challenges presented by routines not implemented on this board.

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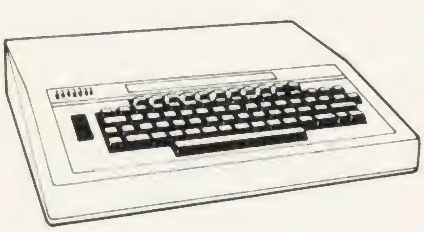

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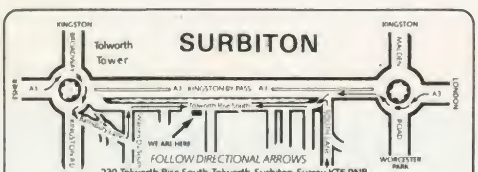

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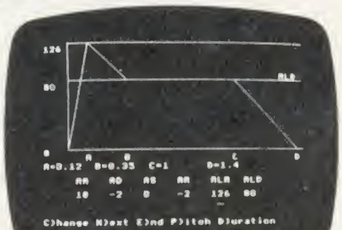

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ON THE TRAIL OF INTELLIGENCE

Simon Dally introduces this month's competition with the tale of the Turkish delight which fried

Long before computers were invented people were fascinated by 'intelligent' machines which appeared to have a will independent of their maker. Even today we can be mesmerised by dumb machinery such as toyshop 'robots' doing tasks which would excite no interest if carried out by human beings.

In 1769 an engineer named von Kempelen astounded the Viennese Court with a machine called The Turk. It consisted of a life-size human figure dressed in a turban and seated in front of a box, the top of which was a chessboard.

To the amazement of the spectators, not only did the machine talk, it also appeared to be voice-activated. It had a vocabulary of around 30 words and, via a complicated system of levers, grabs and pulleys, could move both its own and its opponent's pieces. Even more intriguing, it beat virtually everyone who challenged it.

Over the next few decades the machine went on tour. It played against Napoleon, and in Berlin attracted 100,000 paying spectators in three months.

Numerous accounts appeared speculating about The Turk, one by Edgar Allan Poe claiming there must be a human chess-player concealed inside it.

A sceptical American reporter, in the best Lou Grant tradition, noted that wherever The Turk appeared, the local chessmaster was not to be found. More pertinently, a cry of 'Fire!' would make the machine rock violently!

We shall never know how this contraption worked (it perished during a fire in Philadelphia in 1854), but the likely explanation is that a dwarf or small adult was concealed within the machine, while a strong player would be part of the audience, passing on coded signals.

In the computer age of artificial intelligence – whether machines canbe made to behave more cleverly than ourselves – has provoked considerable and acrimonious debate, both theoretical and practical.

One of the pioneers of computer theory was Alan Turing, who devised a test for AI. In essence this laid down that if you put someone into a room with no indication of who or what he was communicating with (eg a teletype machine), would he be able to recognise what was at the other end?

In the 1960s, another pioneer in the AI field, Joseph Weizenbaum of MIT, developed a program called *Eliza*, versions of which are available on several micros.

'Talking' to Eliza is both intriguing and frustrating. Eliza acts the part of a sympathetic psychoanalyst, probing away and making sympathetic noises – but never offering solutions.

In 1968 at MIT an incident occurred which has since passed into folklore. One version goes as follows. A student came into a computer room one night seeking to use a terminal. The only unoccupied one had a note attached to it saying, 'This terminal is reserved for Dr Bobrow'. Knowing Bobrow often worked from his home terminal, the student dialled it up (so he thought – in fact he hooked into Eliza) and the following conversation ensued:

Student: Can I borrow your computer terminal tonight?
Eliza: Why should you wish to borrow the computer tonight?
Student: Because I want to do some work.
Eliza: Is your work important to you?
Student: Yes
Eliza: I see.
Student:.Well???
Eliza: What do you mean, 'Well'?
Student: Can I use your computer time?
Eliza: Let's discuss further why your work is important to you.

After ten minutes in this vein, getting nowhere, the enraged student telephoned Dr Bobrow at home, rousing him from sleep, and the sublime descended to the ridiculous:

Student: What the hell do you think you're playing at?
Dr Bobrow: What do you mean, what the hell do I think I'm playing at?

It is arguable that the machine passed the Turing Test with flying colours, though a purist might object on the grounds that the human being had not been told his task was to distinguish between man and machine.

A RAFFLE was conducted at the Christmas Computer Convention. The tickets, numbered from one upwards consecutively, were sold from booklets, each of which contained the same number of tickets. All tickets which had one or more digits the same in their number were printed on grey paper. Tickets whose numbers consisted of totally different digits were printed on yellow paper.

There were an equal number of grey and yellow tickets and all tickets were sold. Funnily enough, only one booklet consisted entirely of tickets all of the same colour and by an odd coincidence the winning ticket was exactly the middle ticket of this booklet. The second prize was won by the person who had bought the highest numbered ticket.

What were the respective winning numbers? Answers on a postcard please to March Competition, *Acorn User*, 53 Bedford Square, London WC1B 3DZ, to arrive not later than Tuesday, April 5. Two Acornsoft packages go to the lucky winners (please state which machine you have.)

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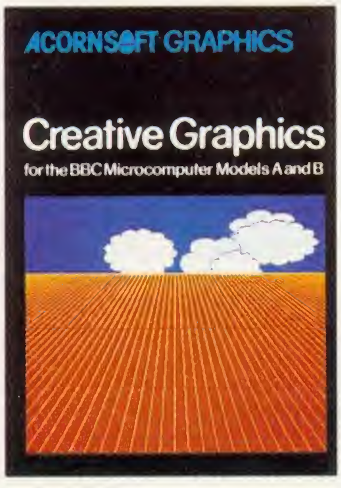
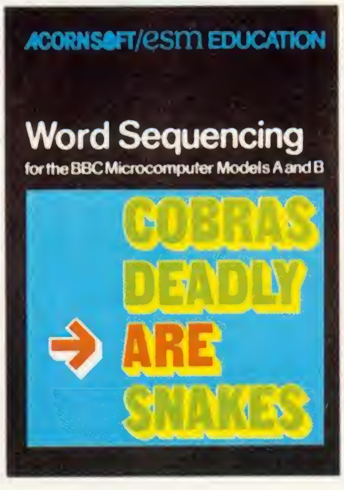
<u>Further education for everyone.</u>

Creative Graphics, which includes the book 'Creative Graphics on the BBC Microcomputer' (price £17.45), provides 36 programs on cassette producing a spectacular range of pictures and patterns in full colour, including animated pictures, recursively-defined curves and three dimensional shapes.

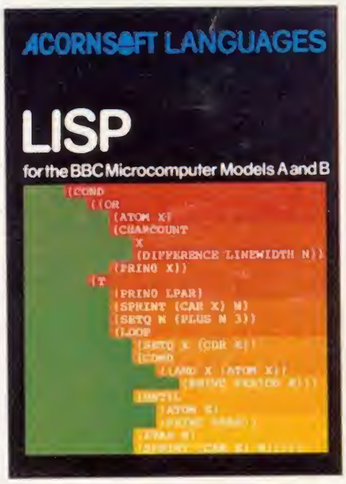
Word Sequencing (price £11.90) contains three word sequencing programs on cassette. Each program presents a series of jumbled words which must be arranged on screen to form either a proverb, nursery rhyme title or a sensible sentence.

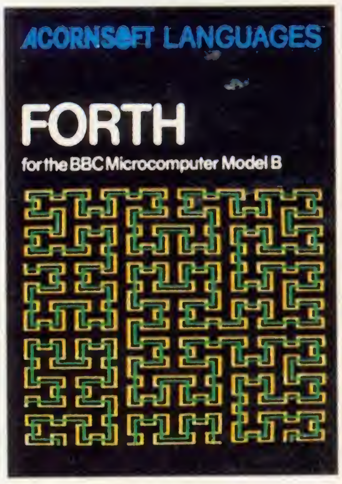




<u>Learn more languages.</u>

LISP (price £24.35) is the fundamental language of artificial intelligence research.





It consists of 5.5K of machine code interpreter, plus 3K of initialised LISP work-space containing utilities and constants. It comes complete with a book that introduces you to programming in LISP, as well as some fascinating applications.

FORTH (price £24.35) is a complete implementation of the FORTH language to the 1979 standard specification for the BBC Microcomputer Model B. This much acclaimed programming language is also accompanied by a specially written book explaining all you need to know.

<u>Mind-boggling games.</u>

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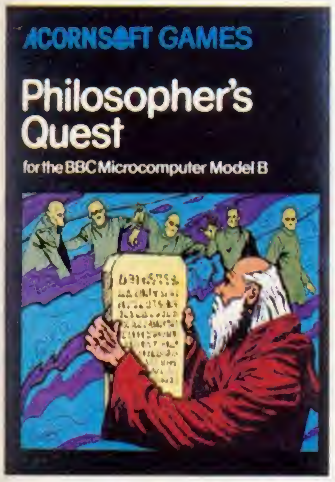

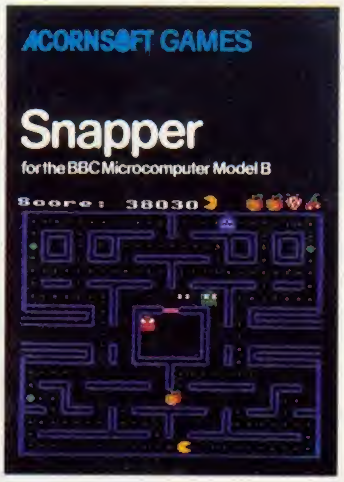

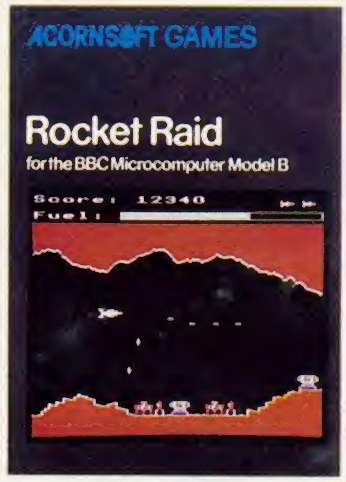

describes back in plain English your progress through a fascinating world of fiendish puzzles to be solved.

Snapper (price £9.95) is a colourful game where you guide your 'snapper' through the maze, eating dots and fruit and avoiding the creatures that chase you. Complete with full sound effects, score and a ladder of high scores.

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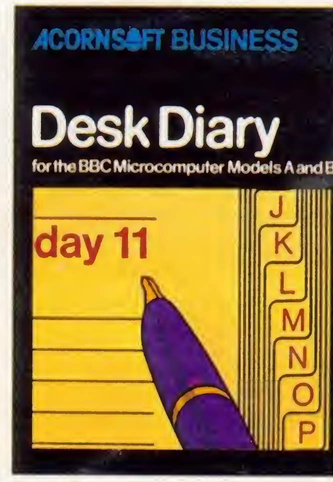

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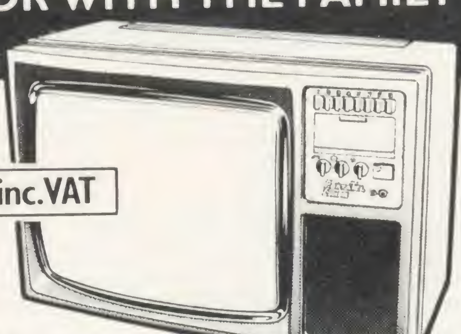

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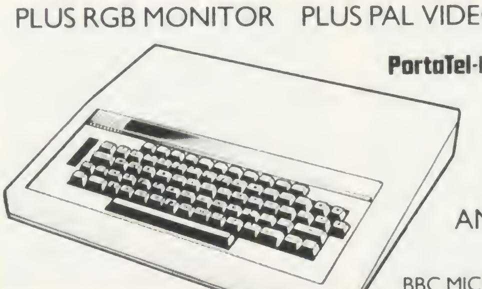

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ASSEMBLY WITH THE BEEB

□ *Assembly language programming for the BBC micro by Ian Birnbaum, Macmillan, 305pp, £8.95*

THE cover material proclaims this book will appeal to three types of reader. First, owners of BBC machines who wish to delve into assembly language programming; second, the student or teacher of computer science requiring a structured course, and third, the person with a knowledge of Basic who is thinking of buying a BBC machine. The book does contain material appropriate for each category, but the attempt to be all things to all men results in a book not ideally suited to any. However, Ian Birnbaum has pieced together a considerable amount of material making it a useful source of information.

In common with other recent books, the author relies heavily on relating assembly language programming to imitating the statements and structures of Basic. The limitations of this approach in its assumption that most people quickly pick up elementary Basic are unimportant if those that don't are not going to be interested in assembly language programming. This assembly language comparison to Basic works well in places. In particular one chapter gives a clear introduction to loop structures by contrasting the FOR . . . NEXT and REPEAT . . . UNTIL structures of Basic with their assembly language counterparts.

The BBC assembler is almost unique in terms of its friendliness, ease of use and the accessibility of operating system routines. It is these features that one might expect the book to make use of early on, but, disappointingly, this is not the case. It opts instead to stay with a conventional 'computer science' start – block diagrams of computer systems and an ample helping of binary arithmetic. Throughout the book are numerous exercises for the reader to try, solutions for which are provided.

Many programs are included, although most are poorly laid out listings produced on a dot matrix printer. Nowhere to be seen is there a copy of any output produced by the assembler. Comments follow the listings in the style – 'lines 20-50' and a description of the section. This has resulted in comment appearing several pages adrift of the listing in some cases. How comments appear is perhaps just down to personal preference, but the right hand side of an assembly language listing is usually empty so why not use it?

The programs are, nevertheless, useful, including a high resolution screen copy, a monitor program and several sort routines. One chapter consists entirely of such utility programs.

One omission is a full treatment of the Beeb's powerful CALL statement. The ability to pass numerous parameters to a machine code routine from Basic is a valuable feature of the BBC machine. Even the standard operating system calls receive limited attention yet it is in these areas that the BBC machine allows the assembly language programmer to get a lot out of the machine with little effort.

Also marketed, but not available with the review copy of the book, are two software cassettes (£9 each). As well as programs from the text the tapes contain four additional utility programs including a disassembler.

The race to produce the first book on assembly language for the BBC micro has been won. The author has done his bit by supplying plenty of useful material, but more care and control at the publishing stage would undoubtedly have improved the end product.

It contains much useful information (without an index) which may appeal most to the enthusiast, but it does not provide the gentle introduction necessary to woo the novice into the delights of assembly language programming on a very special machine.

John Ferguson
Tony Shaw

IT'S AS CLEAR AS MUDD

□ *Pascal from Basic by Peter Brown, Addison Wesley, 183pp, £6.95*

FROM its title, you might think this book is intended solely for those learning Pascal as a second computer language. This is emphatically not the case: the book is more a treatise on general programming style.

Professor Brown is an experienced teacher and skilled author. He has produced a book which is a fine amalgam of lucid, witty writing and clear, detailed information. His explanation of the world of Pascal is ably assisted by such characters as Professor Pimple, an academic devotee of Pascal, whom nobody understands, Bill Mudd, a stubborn devotee of Basic, whose programs never quite work and Mr Perkins the security man, keen on reliability.

Users of Basic with BBC machines may consider some of the criticisms of their language unfair. This is because Professor Brown has unfortunately chosen to use the rather old ANSI minimal Basic for his standard. BBC Basic has learned from the block-structured languages.

This book is however far from being an attack on Basic. Where praise for the language is deserved such as in string manipulation, it is given. The

page 80►

THE PLOTS THICKEN

□ *Graphs and charts on the BBC microcomputer by Robert Harding, Acornsoft, 104pp, £7.50 (cassette £9.95)*

THIS is a set of mathematically-oriented, graph-plotting utilities written as Basic procedures. These are 'compiled' into complete programs using the *EXEC command to extract programs from the cassette. The material covered includes histograms, pie-charts, plotting functions of one and two variables and stereo views of functions of two variables. The book consists of procedure listings, a description of each procedure and how to use it, and a liberal number of illustrations of the utilities in use.

The material is ordered into three levels to enable high or low level access, depending on the user's requirements. Level three, the highest, includes complete programs ready to run, that are loaded using CHAIN. These are then supplied with data from the keyboard, or a function is selected to generate the data points. For example, when using the level three histogram program, points are supplied, one at a time from the keyboard, together with a selection of options such as colour, bar base, width and title.

In level two, a procedure, rather than a complete program, is used and this has to be supplied with the data set up in global arrays, together with option selection as procedure parameters.

This is an excellent approach from an educational viewpoint, a user being taken through the facilities available in each utility, before moving on to tailor the utility for his own purpose. Indeed, the value of the package is likely to be as an adjunct to the teaching of secondary school mathematics.

Level one the lowest level, is similar to level two as far as 'compiling' is concerned, but allows access to more detailed facilities, setting as a mathematical to plotting transformation and setting viewpoints so more than one graph can be displayed on the screen.

In both level two and level three complete example programs are given showing how the procedures should be driven. Incidentally, one practice the author adopts is to start the names of all global variables with "" which is a good way of preventing logical errors due to the programmer selecting variable names identical to those intended for global variables.

The book is clearly written and nicely produced with a spiral binder. Because of their generality, the procedures are lengthy and unless you are desperate to save £9.95 or only want to use one or two utilities, I would not recommend purchasing the book without the cassette.

However, I have three quibbles. First the book is rather expensive for 104 pages, but I suppose you are purchasing a software package rather than a text book. Second the Basic is written in traditional style (although it's an improvement on some of the stuff you see around). Little use is made of mnemonic variable names, spacing and indentation to highlight program structure. I find this somewhat disappointing given that BBC Basic programs can be made much more readable with the facilities available in the dialect. Contrary to popular opinion, writing readable programs only has a marginal effect on interpreter run time. Readability is important with a product such as this if a reader, for example, wanted to muse through the procedures to familiarise himself with graph drawing techniques.

Finally, the surface plotting procedures suffer from the lack of hidden line removal. This is not particularly arduous either in run time overheads or algorithmic complexity for this special case. Without hidden line removal some of the illustrated functions look like crushed balls of chicken wire.

Alan Watt

from page 79

author is quick to point out areas where Basic would be the better language to use. Occasionally this endeavour for fairness is taken to extremes. For example, it is true that the speed of Basic as compared to Pascal depends on the implementation, and that Pascal can be slower than Basic. However, as far as micro users are concerned most Basics are interpreted or at best partly compiled, whereas Pascal is invariably fully compiled at least as far as P–code and runs much faster. For many micro users this is the main criterion for switching to Pascal.

Professor Brown has also given a brief overview of operating systems, a subject generally unfamiliar to users of Basic. What most micros describe as an operating system is in reality just an operating system kernel, providing primitive facilities, such as reading and writing characters, opening files and so on. Basic then provides the operating system command program, with high–level instructions

The BBC micro and Acorn Atom are unusual in having operating systems that also provide high-level commands (for instance, *LOAD, *FX), but even these are rudimentary compared with a fully-blown operating system, such as Unix. Pascal is not interactive like Basic, and so requires an environment (provided by the operating system) to work in. This book gives readers an insight into such environments.

By far the most impressive features are the comments throughout on programming style. It is here that this book will benefit all programmers, whether schooled in Basic, Pascal or other languages. The author emphasises readability and there is a marvellous section on the evils of GOTO.

Lastly, there is great detail on writing large programs which are easily maintained. If you wish to improve your programming ability this is an enjoyable way to do it.

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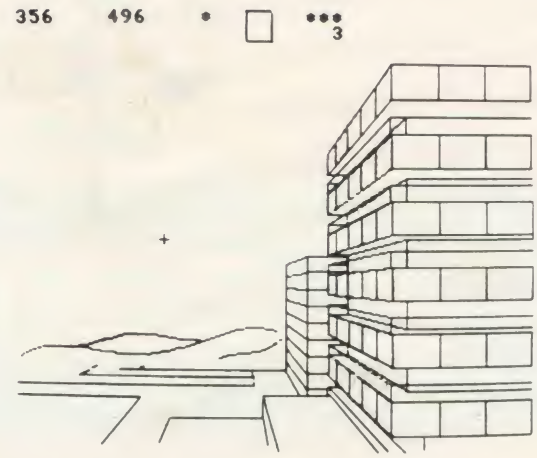

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PRINTERS FOR BEGINNERS.....

George Hill introduces you to the ins and outs of 'hard' copy. He starts off with a description of the types available.

After buying your computer and playing pre-packaged games for a few weeks, the need for a printer will gradually grow. Money spent in acquiring a printer is well spent, and you ought to start saving up now if you don't already own one.

Printers are vital to develop good programming technique, and cut down the length of time spent staring at a flickering television screen. If you copy programs from magazines you will inevitably make typing errors. A printout can be laid side by side with the original, and you can check it much more readily.

Also, as your own programming develops you are much more likely to write legible and well-structured programs if you can construct them with a printout available at each stage. Relationships between the parts are much clearer and the need for sections and explanatory REMs is more obvious on the printed page.

Finally, you can refer to a previous program while typing in a new one, without having to perform any complex manoeuvres.

Apart from program listings, there are also the advantages of having printouts of the results of your programs. Once you own a printer you will design your programs to use it automatically at appropriate moments, and sequences like:

```
PRINT "Results on 1) VDU only,
   2) Printer and VDU?"
INPUT"Type 1 or 2" N
IF N=2 THEN PROCPRINTERON
```

will start to appear in your programs. With some printers you can also copy the graphics screen.

You may later wish to invest in or write some form of word-processing system. Word processing is the greatest development since the typewriter and to take advantage of its wonderful flexibility and capabilities, a printer, and preferably a good one, is an absolute necessity.

Now we know the advantages, let's look at the types of printer which home users, small businesses, or educational establishments could reasonably afford. Teletype machines will not be considered, nor line- or page-printers used in conjunction with mainframe computers. They are far too large and expensive, and their only advantage is enormous speed.

The computer has a limited control over the appearance of the characters printed. Characters are letters, numbers and punctuation marks making up a 'character set'. The computer merely generates a series of ASCII numbers which it sends along the wire(s) to the printer. The printer decodes the numbers, and prints its own version of the character. Thus a change of mode from 2 to 0 on the BBC computer will change the appearance of the characters on the screen completely, but will not affect the printed ones at all. The type of character printed is generated from a source in the printer known as its 'character font'. The font varies, but is usually a pretty permanent feature of the printer, and the appearance of the characters is only subject to minor variation during a run.

There are five types of printer available within our parameters. The basic difference is in the mechanism by which the data is transferred to the paper. They are: daisy-wheel; dot-matrix; electro-sensitive; ink-jet; graph-plotter.

The simplest to understand, and the one producing the highest quality output (but no graphics), is the daisy-wheel printer. The paper is fed, as in a typewriter, across a rubber roller. The character font is a plastic wheel with spokes (figure 1) and the characters are embossed on the ends of the spokes. An electro-magnetic hammer strikes the character head which strikes the ribbon, transferring its images to the paper. The daisy-wheel is rotated until the correct character is in front of the hammer, the hammer is fired, and the whole printing mechanism moves across the paper, printing one character at a time. The speed and sophistication of this process varies considerably with price!

The second type, the dot-matrix printer, is probably the type most likely to recommend itself to the home user. The printhead consists of a series of very fine, strong wires, which are fired individually by solenoids (figure 2). The wires print through a ribbon and the paper is fed over a roller as in the typewriter. The printhead moves across the paper and can print a band of dots.

Typically an 80 character line would have more than 400 dots per

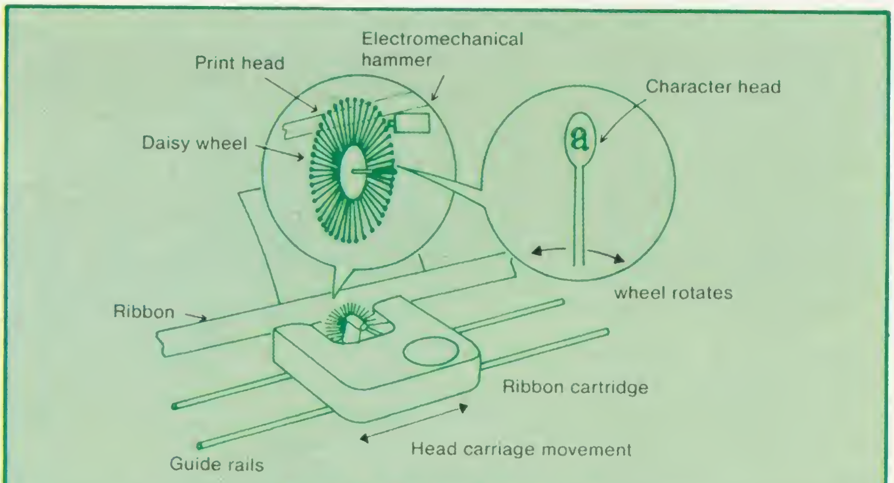

Figure 1. Daisy-wheel printer

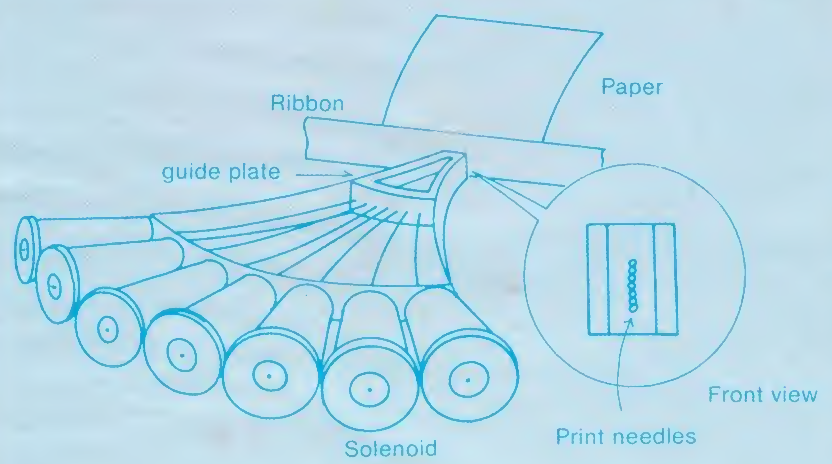

Figure 2. Dot matrix printing

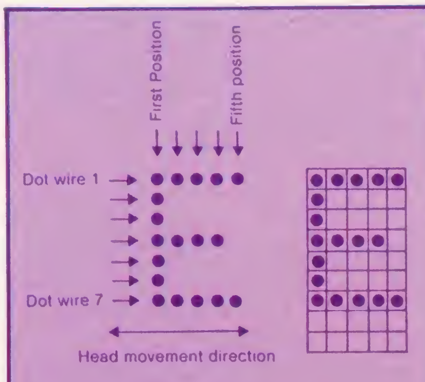

Figure 3. Letter E on 9 by 5 matrix

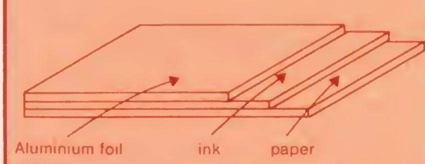

Figure 4. Electro-sensitive paper

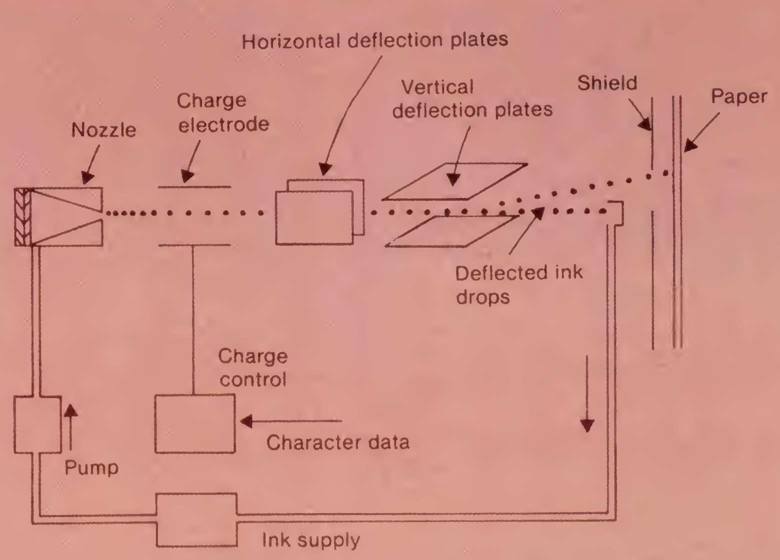

Figure 5. Ink-jet mechanism

line, and the band would be six to nine dots high. Thus each character is printed on a matrix (figure 3). The character font is in ROM in the printer (ie it is stored in a chip on the printer's circuit board). If an 'A' is sent to the printer the appropriate dot pattern is extracted from the ROM, and the wires are fired in the correct order as the printhead scans the paper.

The electro-sensitive system uses special paper which is a sandwich of paper, ink and aluminium foil (figure 4). Printing is carried out by wires in contact with the foil. When the wire is raised instantaneously to a high voltage, a current flows, melting the foil and exposing the ink underneath, which appears as a black dot on a silvery background. The character font is again in ROM.

The latest printers in our price-range are the ink-jet and graph-plotter types. The ink-jet principle operation is illustrated in figure 5. A jet of electrically charged ink droplets is fired at the paper, and deflected by electric fields in much the same way as the electron beam in a television set. The character font is again in ROM, but controls the direction of the deflections.

The graph-plotter type uses fibre tipped pens and draws its image by programmed movements.

Until more is known of the ink-jet and graph-plotter types I shall not be able to give accurate comparisons, so for the present I shall not consider them. The only electro-sensitive I know of is the Sinclair. An article appeared in the November issue on interfacing it to the Atom, but the problems make it a non-starter for beginners.

A list of points to consider when choosing a printer follows. At the cheaper end of the market one desirable feature is traded off against another.

Paper width. Some cheaper printers will only operate on their own size of paper (normally in rolls). Usually this is very narrow, resulting in long thin listings which are not easy to read. In the middle price range, paper width is up to A4 size (about 8.5 inches wide). Only in the larger, more expensive machines can full width computer paper be used. This is unlikely to be a disadvantage to the home user, but

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Paper-feed mechanism. This can be by two methods. First is the traditional typewriter mechanism, where the paper is squeezed between two rollers, one of which is rotated by a motor. This is the friction-feed mechanism. Second is by a tractor-feed mechanism, where the paper has holes down its edges, and is fed over motor-driven wheels which have teeth which correspond to the holes (figure 6). The holes are often in perforated strips which can be torn off after printing is complete. This mechanism gives more accurate control, and is preferable for graphics.

Paper for friction-feed normally comes in rolls and often needs a special roll-holder, which is not always supplied as standard. Tractor-feed paper comes in packs of perforated sheets, folded like a fan, hence fan-fold paper. Any type of printer might have either mechanism, so you need to be specific in your enquiries. It is desirable to be able to use single sheets of ordinary paper. This will only be possible in a printer with the friction-feed option and you will have to feed the sheets in by hand, unless you have a very expensive special attachment – beware of paper end detectors which switch off the printer in mid-page.

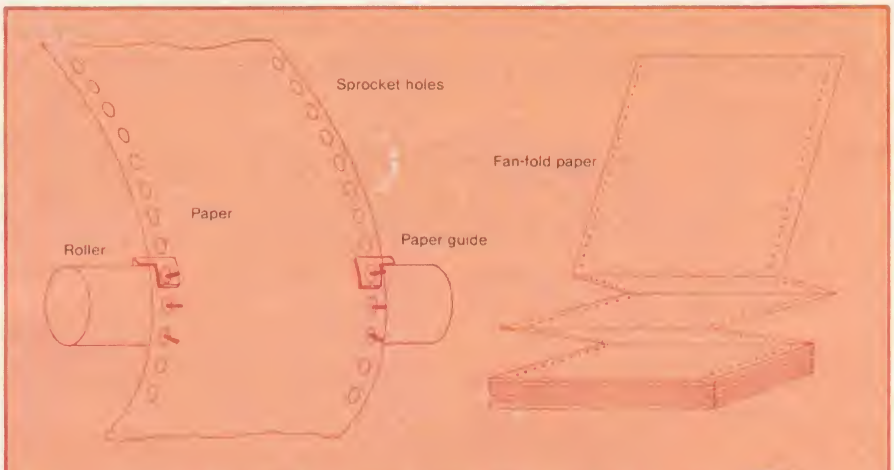


Figure 6. Tractor feed and fan-fold paper

Printing speed. This is often quoted in advertisements in c/s (characters per second), and must not be confused with baud rate, which is the rate at which electrical signals can be transferred to the printer from the computer. The latter will be discussed in the next article in this series. Printing speeds vary widely from 12 c/s to 300 c/s. Beware of quotations of lines per second unless you are sure of the characters per line. For long programs and lists you will find a printing speed of less than 40 c/s a disadvantage.

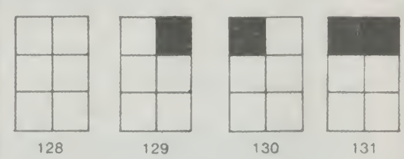
Printing styles. Major changes may be made relatively easily on a daisy-wheel printer by changing the wheel. Thus italics, joined script, and greek alphabets may be available, but you cannot change the wheel in the middle of a run. So, unless the characters you want are all on the same wheel, you won't be able to use them in the same printout.

Dot matrix printers normally have only a single basic appearance for each character in the font, but a variety of printing methods produces a wide apparent variation. For example, the letter 'A' is always the same dot pattern, but the dots may be printed closer together, doubled up, further apart, producing different appearances (figure 7). Some of these features are under software control (ie you can change them by sending the appropriate control characters or escape sequences to the printer from the keyboard, or from within a program). Some need changes in switch settings or link placements within the printer. 'Control characters' are those with low ASCII values, generated by using the control key, which subtracts 64 from the ASCII value of any key pressed simultaneously (eg CTRL A sends 65–64, ie 1). 'Escape sequences' are generated by sending ESCape (ASCII 27) followed by a variety of letters or numbers. Each printer has its own function assigned to each, and there is little agreement between manufacturers.

10 REM normal	10 REM double width
10 REM double height	10 REM double width and height

Figure 7. Dot-matrix print styles

Graphics capability. There are two forms of graphics printing available. The first is the 'chunky graphics' character set, based on a three by two matrix, and controlled typically by ASCII values 128 to 192.



Chunky graphics

Manufacturers tend to refer to this as 'full graphics capability', but it requires some mathematical ability, good programming and much experimentation to use, and even then it has disadvantages.

The second is never available on daisy-wheel printers. It involves the ability to control each individual dot wire in the printhead, and hence produce any dot pattern under the control of the programmer. Here the number of dots per line and the degree of control are critical to performance, and the ability to produce a 16 colour dump with different patterns for each colour would require a minimum of 480 dots per line, and 640 or 960 would be more desirable. Satisfactory, though much more limited, pictures can be printed with as few as 256 dots per line, but any fewer than that involves splitting the picture up and printing it in parts, at least for the BBC computer.

Line spacing and wraparound. Linefeeds can be tricky things on printers. First you may be able to vary the amount of space between lines, and indeed this may be crucial in graphics printing. This ability may be under software control, may need changes in internal switching, or there may be no control possible. Second, the printer may interpret a carriage return character (ASCII 13) either literally (ie it returns the printhead but continues printing on the same line) or it may perform 'auto-linefeed'. That means the paper is advanced every time a return is encountered. Again control may be under software, or switched, or not available. Third, if a line is overlength, the printer may interpret a carriage return as an instruction to do one of three things: truncate the line at the maximum width set, ignoring all characters above the pre-set linelength; overprint the excess characters on top of the first characters on the line; perform a linefeed and print the excess characters on the next line.

Although you may think the last is the only sensible option, there are occasions when it is desirable to have this feature under your control. It is known as wraparound.

Interfacing. This will be dealt with as a separate topic in a future article. The two forms are called 'serial' and 'parallel', and the BBC micro can cope with either. Some printers can be switched from one form to the other, but this usually involves setting switches located in the bowels of the machine.

Reliability. In my experience modern printers are reliable, and are unlikely to give trouble in the course of normal moderate use. Like other delicate mechanisms they do not like major abuse.

Noise. If you are noise-sensitive, as I am, the clatter and whirr of noisy parts can be annoying. Daisy-wheels are generally more noisy than dot-matrix, and cheap printers are more noisy than expensive ones.

What should influence you in your choice of printer, if it is to be between daisy-wheel and dot-matrix? Unless the *primary* purpose of your printer is the production of top quality printed matter in the form of letters and circulars, or you need to produce multiple carbon copies, or you are really buying a typewriter, and its use as a printer is a bonus, you should probably opt for the dot-matrix printer. The quality produced by middle priced dot-matrix printers will satisfy all but the most fussy (particularly if you fit a new ribbon regularly). The added ability to reproduce graphics is probably the deciding factor.

How much should you be prepared to pay? Prices vary enormously in the range £60 to £2000, and on the whole you get what you pay for. It is however unlikely that the home user should pay more than £400.

Some of the latest printers will be reviewed in these pages to help you choose. But remember, you're buying, so take a good look and, if possible, use it first.

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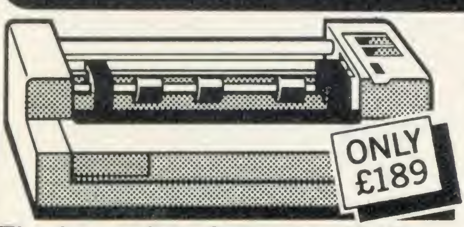

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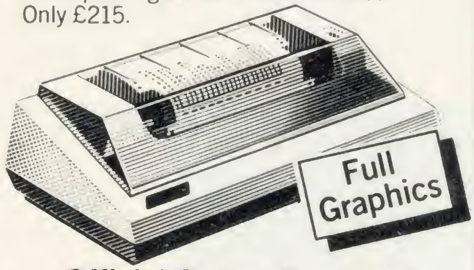

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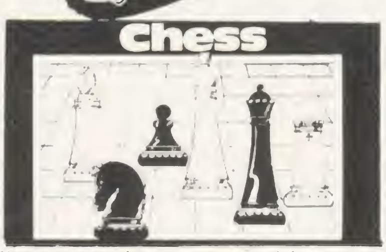

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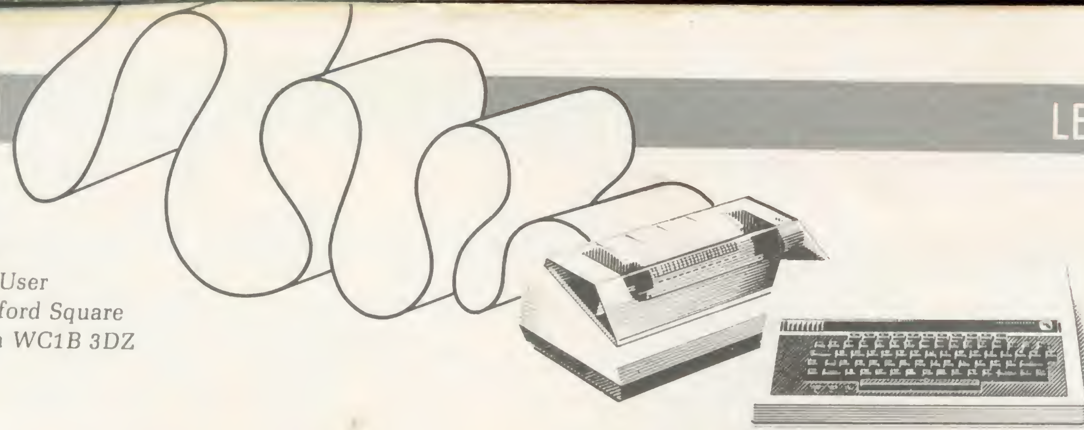

Letters
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Back issues, hardware and user groups

Sir, Last September I purchased a BBC model B and have thoroughly enjoyed the machine. Sometime before I purchased my machine I read an article in which it was stated that owners of the BBC micro would receive two complimentary copies of *Acorn User*. However, I have not received any complimentary copies, so I assume this practice has now been stopped, no doubt for sound reasons.

I was pleased therefore to see your first nationally circulated November issue and immediately purchased it. My compliments on the presentation and contents of the magazine. This has been reinforced by your December and January issues and I have now placed a regular order with my local newsagent. There is however one problem; I do not possess copies of your first three issues. Would it be possible to obtain these?

There are several other queries I would like to raise with you which you may consider worth looking into.

First, my computer functioned perfectly (excluding ROM bugs) for several months. However, recently I have experienced problems with flashing across the TV screen and picture distortions. On investigation I found the lead to the TV had a fault – the earthing wire to the input connector on the lead was not soldered, merely wrapped around. After soldering this on the problem disappeared.

What about articles on hardware peripherals? I would like to make a combined joystick/numeric pad which would give greater flexibility in program applications than a simple joystick/fire button. Take for instance *Planetoids*, this requires seven inputs. A joystick/numeric pad would accomodate this easily.

On the same lines, I was impressed with your article on interfacing discs to the Beeb, particularly those used for the TRS80. What about the Aculab floppy tape – is there any chance of interfacing this? They can be obtained for £125 for a drive and £50 for slaves.

I note facilities are advertised for teachers through the auspices of your magazine. Do you know if individuals outside the teaching profession can obtain these? They would be useful to our small local user group at ICI in Huddersfield.

B.D.Gott
Huddersfield

The first two issues of ***Acorn User*** **(July/August and September) were mailed out free. Unfortunately, these have now been distributed, and the dwindling supplies have to be reserved for subscribers, unless you are prepared to pay for them (see back issues and subscriptions information, page 73).**

The point you make about duff soldering is an important one – many problems with TVs, and cassettes, can be put down to bad connections.

Your idea about the joystick/numeric pad has been noted, and we hope to carry an article on this in the future. Joe Telford's article on the lightpen may be of interest – and George Hill on printers.

It would be nice to cover every disc under the sun, but space doesn't allow this. The article on discs you mention in January's issue should, however give pointers to using any brand of disc – and your dealer may be able to help.

The facilities which user groups negotiate depend on how hard you try. The teaching user groups rely on self-help and information exchange. Your local dealer may give you discounts and your bargaining power would undoubtedly increase if you teamed up with other user groups in ICI, or locally.

Many other aids for the teaching profession come from the MEP – a Government sponsored body. Their products may be put on sale – but remember that the software was originally written in individual schools. The MEP just tidies it up, collates it and distributes it.

A lost micro

Sir, In October 1982 I took delivery of a model B BBC micro which developed some problems. I sent the machine back to Wellingborough, omitting to insure it, and I have been told on the phone that they have no record that it arrived.

Could you please circulate the number of my micro (119843, and on the keyboard 11172) to make it more difficult to dispose of?

B. Ross
West Sussex

Sadly, we have heard of several machines disappearing in the post. It would obviously be wise to take out some form of insurance with the Post Office when you send your micro off for repair.

'B' software on upgraded 'A'

Sir, Recently I sent off a coupon to Acornsoft and was pleased to receive a colourful brochure describing their programs for the BBC micro. My one problem is that the programs are described as either 'model B' or 'model A' compatible. As I possess a model A with the memory upgrade to 32k, I would be pleased if you could tell me which model B programs will run on such a machine.

Peter Waymont
Essex

You will be able to run all model B games on your micro so long as you have a 6522 VIA (versatile interface adaptor) chip. A few games do not require this chip, but you will have to ask your dealer which these are. The chip plugs into the IC69 socket on the board inside the computer. You can get these chips from dealers, who will fit them in a couple of minutes. The cost will be around £11 including VAT.

Error puzzle

Sir, Out of curiosity and not need, I wish to make a query about our BBC model B computer.

When we switch it on and immediately type OLD we get the error message 'Bad program'. Then, if we type RUN, 'Syntax error in line 255, Bad program' is returned. Type RUN once more and two lines of rubbish are shown. Typing RUN once again and either we are told: 'Mistake' or 'No room'. Or the top few lines of the display 'fizzle' up and off the screen – in both cases all keys except BREAK are disabled.

Until we decided to always type NEW before entering a new program, we got the error message 'No room' very quickly, almost as if our micro's chips are full of nonsense.

Is this normal?

Helga Zunde

No, this is not normal! We feel that your micro has RAM problems – you can get these changed by your dealer.

Printer choice and EPROMs

Sir, I am considering buying a printer for my 32k model A. I have added a printer port and two chips – IC70 and IC69. Is there any more hardware to be added before a printer can be used? I have up to £200 to spend. Are there any printers that are recommended for the BBC?

I have been having problems loading files to and from cassette and I believe it is my OS o.1 EPROM. Promises were made that this would be replaced free of charge – is this service now available?

Is it possible to squeeze about 6k more of variable storage above my 32k using either extra hardware or re-allocating memory?

Jonathan Brenchley
Sussex

To answer your first question, you now have everything needed to drive the printer. There are no printers recommended by Acorn for the Beeb in your price range – and for under £200 your choice will be limited. See George Hill's article (p67) for some advice. We also reviewed the £70 Amber printer last month. This printer can also be used with the Atom.

Point two: yes, this service is now available and you should be able to change your EPROMs for a series one chip through your dealer.

It's not directly possible to squeeze out more memory. The second processor will allow more program and variable space but it's not possible without it due to the 64k memory limitation of the 6502 microprocessor.

'Guide' errors

Sir, page 453 of the BBC *User Guide* contains an error. In the third line of the page, it is stated that OSFIND returns the channel number in the Y register. The channel number is actually returned in the accumulator, A. Assembler programmers will be interested to learn this.

Washington Jordan
London

Here are two other errors: Page 179, line 10120 should read:

MOVE X%,Y% not MOVE %X,Y%

and page 518 (index) the entry for PRINT in hex should read ~ PRINT in hex *18,410*.

Advice on screen photos

Sir, I wish to take transparencies of text from my TV screen. As you use such pictures, can you help me with any information?

Eric Jones
Clwyd

Most photos used in this magazine showing screen displays (see February issue page 57 'Rocket Raid') are taken from a monitor which provides a much sharper, steadier picture than a domestic television.

Our photographer offers this advice: mount the camera on a tripod; use a single lens reflex camera with a long focus lens (135mm is ideal). The room must be dark with no screen reflections and obviously you don't use a flash. Frame the picture so only the screen is in view. Use 64ASA film for still displays, 200ASA for moving displays and shutter speed 1/25th second. The best aperture setting must be discovered, by trial and error – use your light meter to determine an initial setting and bracket each way.

This advice will produce the best pictures. For results which are quite acceptable, but not as professional, the most important points are a dark room and a steady camera.

Graphics program won't work

Sir,
On running graphics program 2 (page 54 of the December issue) on my model B, despite scrupulous checking and re-checking I could get nothing other than the message: 'Not local at 10220.'

Who or what is at fault? I would welcome any suggestions.

Keith Leadbitter
Hampshire

We tried this procedure many different ways, and the only way to reproduce the error message you were getting occured when the program executed the procedure without calling it.

All procedures should be put beyond the END statement of a program so they cannot be executed, unless called by name from within the program. For example, consider the following lines:

```
100 DEF PROCprint
110 LOCAL N
120 PRINT "Hello"
130 ENDPROC
```

If this is run it will produce the error message 'Not local at line 110', whereas the same procedure called in a program will execute with no errors. For example:

```
 10 PROCprint
 20 END
100 DEF PROCprint
110 LOCAL N
120 PRINT "Hello"
130 ENDPROC
```

We hope your program runs, as the teletext mode is such a nice one to use.

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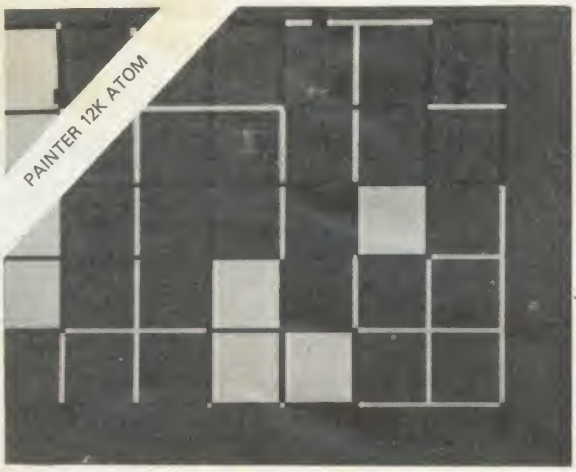

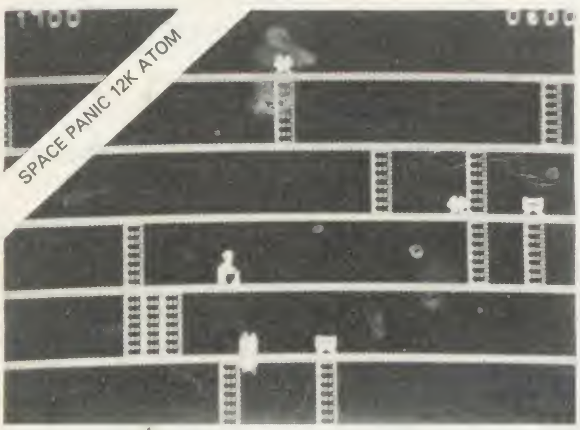

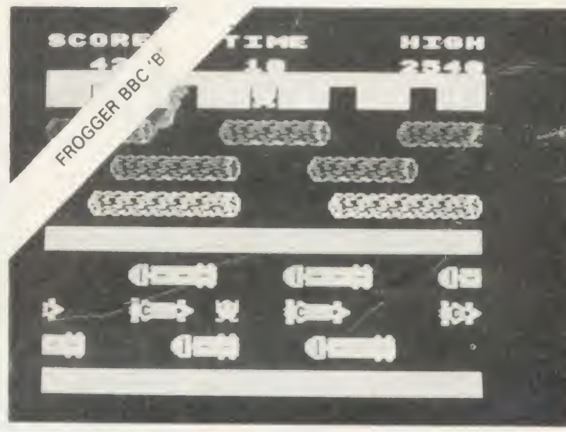

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